THE NATIONAL AVIATION SYSTEM PLAN

1970 - 1979

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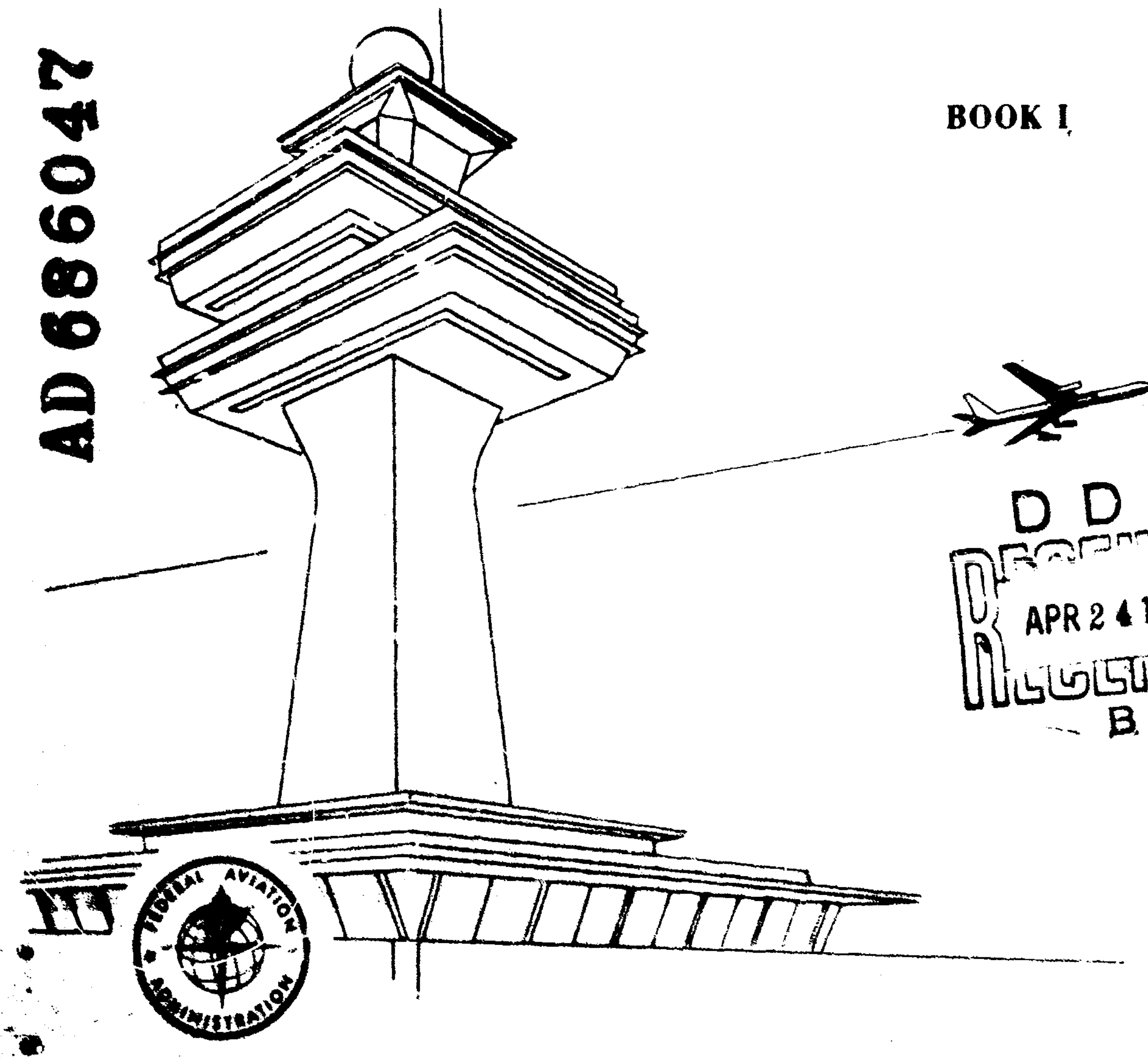
BOOK I



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BOOK 1
1/27/69

BOOK 1. SYSTEM REQUIREMENTS AND CRITERIA

TABLE OF CONTENTS

BOOK 1
1/27/69

PART I - GENERAL

PART I - GENERAL

CHAPTER 1. INTRODUCTION

This document, "The National Aviation System Plan," is a step in a major effort being taken by the Federal Aviation Administration to achieve more effective long range planning of the National Aviation System.

Its purpose is to provide the public with background material for discussion at "The First Annual National Aviation System Planning Review Conference" scheduled by the FAA on April 23-25, 1969, at FAA headquarters in Washington.

The results of these discussions will assist in future agency planning efforts. Following the conference, it is anticipated that industry participants will wish to submit for FAA consideration documented, substantive contributions which will be helpful in preparing the following year's plan.

This document is divided into the following subject areas:

- Planning Forecasts
- Air Traffic Control
- Air Navigation
- Communications
- Aviation Weather and Other Supporting Services
- Airports.

These subject areas are treated in two volumes:

- Volume I relates to System Requirements and Criteria
- Volume II relates to the financial plan for each subject area.

Note: An additional section dealing with a proposed study on cost allocation for the federal airways system is included.

A more detailed explanation of the organization of the document appears on page I-5.

The National Aviation System in its broadest sense encompasses the manufacturers of aircraft airframes, engines and components; the private, business and airline operators of aircraft; the regulators of the economic use of aircraft; and the providers of the airways, the airports and ground access facilities and services.

The Federal Aviation Administration is directly responsible for the safety regulations applicable to the air vehicle and the operator of the vehicle. The FAA is also the provider of airways facilities and services, and has statutory responsibilities related to airports and other environmental and support services and facilities.

Long range planning for airways and related support services and facilities provided by FAA has always been difficult for a number of reasons. The principal one has been the lack of suitable administrative machinery with industry and public participation for achieving such planning on an orderly basis. Subsidiary reasons are that: (1) dynamic aviation growth requires quick "operational" decisions; and (2) Congressional appropriations and federal budgeting procedures have discouraged long range planning.

The Federal Aviation Administration is therefore now taking the first step toward providing the administrative machinery by which better long range planning can be accomplished -- not only for airways and related matters -- but eventually for the total aviation system.

This is being done by the inauguration of an Annual FAA Planning Conference in consultation with industry and the interested public. By this process a continuous, systematic statement of FAA plans can be developed on a ten-year basis. This should provide the aviation industry, the Congress, the Administration and the interested public with a basis on which management decisions can be made regarding technological development, investments, finance and governmental policy.

Limitations of this Conference

This first conference relates primarily to those programs which require a major portion of the agency's investment resources; it does not address itself to all of the major problems facing the government and industry segments of the aviation community. This initial effort is focused on that part of the National Aviation System which relates to the movement of air

traffic. However, additional subjects such as forecasting air traffic demand and aircraft development, airport planning, and airport design standards, as well as cost allocation are included to provide background for the discussion of air traffic and to provide a basis for more comprehensive discussions and planning efforts envisioned by the new policy of consultation and planning.

Among the major issues which are <u>not included</u> are:

1. <u>Environmental Considerations</u>. Some major environmental considerations which are not discussed in this plan are newly developing and are not always related to FAA's statutory responsibilities. Principal among those not discussed are the effects of aircraft noise on the national aviation system. Similarly, air pollution is an environmental problem just now being defined which is reserved for future discussions.

2. <u>Airport Terminal Congestion</u> is not discussed insofar as it relates to the growing volume of passenger and baggage traffic in terminal buildings; these matters are primarily localized and require individual treatment by airport authorities/airlines/air taxis, etc.

3. <u>Inter-modal Transportation</u>. Airport access is a growing problem which cannot be totally resolved by FAA and allied aviation interests; a broader basis must be developed for future resolution.

4. <u>Aeronautical Safety Standards</u>. Other safety programs not directly related to the flow of traffic are already covered by other agency/industry planning endeavors and therefore will not be a subject for review at this time.

5. <u>Air Service Patterns</u>. Although the economic regulation of aircraft operators has a significant impact on the planning of airport and airways facilities, this is a subject involving intra-governmental relations not appropriate to this conference.

Other Limitations

There are four other limitations to the data presented in these documents which are of primary importance.

1. <u>Aeronautical Forecasts</u>. The forecasts represent the results of existing forecast methodologies. As in any projection for the future, many assumptions are made and some pertinent factors omitted.

As it is not logical to forecast air transportation growth in isolation, the forecasts are deficient to the extent that they do not consider the possible future trade-offs in a total transportation environment brought about by shifts in modal demand. For example, the institution of a publicly acceptable high speed ground transportation system along high density, short-haul corridors within the country could have an impact upon air growth. However, more experience must be obtained before this impact can be included in aviation forecasts.

2. Implementation Criteria. Modifications, improvements, additions and deletions to the air traffic control and navigation facilities are normally made upon a set of national criteria developed and approved by the Federal government. The plan represents current thinking about these criteria. In some cases, the criteria is well established and has not been reviewed for a considerable span of years. In other cases, criteria have not been fully developed and are tentative or proposed only. All criteria are subject to change. These changes may be based on further analysis of benefits and costs, technological changes, environmental changes, safety standards, or other relevant factors. In no case are they considered to be final. Suggestions for development of methodology, new criteria and related benefits and costs are solicited.

3. Resource Allocations. The levels of funding, based on the existing criteria, goals, and requirements represent a best estimate of the resources needed to meet demand. It is to be clearly understood that the presentation of the proposed plan and the subsequent meetings do not reflect any commitment on the part of the Executive Branch of the Federal government or the Congress to provide funds at the levels indicated or for the purposes stated. Neither is it to be construed as a plan for multi-year financial commitments.

4. Military Requirements. In addition, there are always limitations in the use of terms and language. While it is stated that the plan covers the National Aviation System, it should be recognized that it is primarily directed toward civil, domestic, and Federal needs. Little mention is made of the military system and none of military requirements. Except insofar as joint-use of civil facilities is involved, this segment of the overall system is excluded by intent. It does not, however, minimize its importance to the general welfare.

The National Aviation System Plan

This National Aviation System Plan document is a compilation of Federal Aviation Administration programs that generally comprise the elements of the National Aviation System under FAA's jurisdiction.

In preparing this plan, FAA has concentrated on presenting a picture of requirements, goals, criteria and plans for in-service improvements and system modernization falling primarily in the Facilities and Equipment (F&E) and Research and Development (R&D) investment program areas.

The document is divided into two parts as follows:

BOOK 1 - System Requirements and Criteria

This book deals with the policy and criteria of FAA with regard to five (5) service and facility areas (ATC, Nav Aids, Communications, Weather and Airports) in terms of the following characteristics:

a. System Requirement: An identified need which is to be fulfilled if safety standards are to be maintained and foreseeable aviation growth accommodated.

b. System Description: A narrative description of the method by which the agency elects to fulfill the requirement, whether it be hardware, procedures, regulations, or a combination of these.

c. System Goal. The expected results to be attained within the period of the plan.

d. Criteria for Implementation. The minimum level of aeronautical activity or other bases which must exist for specific components to qualify for implementation.

e. Bibliography. The statutory, regulatory, or administrative documents which govern the agency's actions and plans.

BOOK 2 - Plans

This book contains the proposed investment plans of the FAA for the ten year period (1970-1979) for each of the FAA related services and facilities (ATC, NAV, COM, Weather, Airports).

These investment plans and system requirements are the ones currently approved, or at present considered desirable, by the Federal Aviation Administration. They are subject to change based on increased technological knowledge, improved

systems analyses, general policies of the Department of Transportation and other review authorities and inputs from other segments of the aviation community.

All dollar estimates will be subject to ultimate approval by the President and the Congress.

For the 1969 NAS Plan, the investments are identified in terms of budget appropriations for Facilities and Equipment, and Research and Development. Operations and Maintenance appropriations are shown for the more important but not all programs. The funding is shown for ten fiscal years as follows: (1) 1970 (the budget year); (2) 1971-74; (3) 1975-79.

The 1969 National Aviation System Plan and the inaugural Planning Review Conference are the first steps in organizing the vast national resources available for effective systems planning.

The FAA believes that these new planning techniques and new methods of participatory democracy can be coupled with the traditional resources and ingenuity of the aviation community in meeting the challenges of the 70's and 80's.

We hope you will find it useful, and your contribution is cordially invited.

CHAPTER 2. SUMMARY

Planning Forecasts

The increasingly complex amount and mixture of air traffic in the United States, generated by an expanding economy and improved civil aviation aircraft, create the need for a larger and more technically sophisticated National Aviation System over the next ten years. The extent of the nation's economic and aviation growth expected in this period can be indicated by a number of selected measures.

For instance, population will increase by more than 30 million people, and gross national product by more than $300 billion by 1980 (in constant 1958 dollars). Families with incomes in excess of $10,000 will double. With further improvements in unit productivity promised by new jet aircraft, the airlines of the United States are expected to fly three times more passenger-miles in 1979 than in 1969. Ton-miles of cargo traffic in 1979 will probably increase ten fold in ten years. The air carrier fleet is forecast to increase 40 percent, and its average payload capacity 60 percent. The private and business aviation fleet will increase during the next ten years by about 83,000 aircraft from 122,000 to 205,000. Air carrier and general aviation aircraft operations at airports with FAA control towers will triple, and IFR aircraft traffic will double by the end of fiscal year 1979.

These aviation forecasts assume a National Aviation System which will impose no significant constraints on the future growth of civil aviation. There can be no doubt that a sound economic basis for a surging growth of civil aviation will exist, but without substantial system improvement and expansion, the growth will be retarded.

Agency forecasts for the future technological environment take the form of predicting when applications of known technical feasibility can become operationally and economically viable by identifying future aircraft and equipment under development and determining their scheduled system appearance. During the next decade greater numbers and new generations of civil aircraft will create new demands upon the National Aviation System. Supersonic transports will be flying up to 80,000 feet at speeds up to 2,000 miles per hour. V/STOL transports will be maneuvering at relatively slow speeds and at low levels within the airspace over the great metropolitan centers. Better systems of navigation and communications, air traffic control procedures, meteorological services and aircraft landing facilities for both these kinds of aircraft will be needed. Economic penalties arising from system inadequacies will become considerably greater in the next ten years, as the economy of the nation becomes more critically dependent upon air transportation.

Air Traffic Control.

During the past 20 years, the safe and efficient use of navigable airspace in the United States has required both expansion and technical improvement of the air traffic control system, and the imposition of more discipline upon air traffic. Public demand for greater air safety, in an environment of increased traffic volumes and more mixtures of aircraft with widely varying speeds and pilot qualifications, has required careful and extensive re-ordering of the structure and use of the airspace. As greater demands are made upon the capacity and effectiveness of the air traffic control system in the next ten years, particularly in the major transportation markets, the need for further structuring of the airspace will evolve.

The future ATC system should provide a balanced, efficient expansion of system capabilities in terms of en route facilities and services, terminal facilities and services, flight service stations, airspace allocation and rules, and research and development. In brief, the best means to meet demands placed on the National Aviation System lies in greater technical sophistication -- such as en route and terminal automation of traffic control, high precision navigation systems of greater flexibility, high speed communication systems of greater capacity and reliability, and improvements in traffic surveillance systems.

As average passenger loading per aircraft continues to increase, the total of air travelers exposed to the risk of individual mid-air collisions also increases. With aircraft becoming larger and faster, the need for greater air traffic control services at many airports becomes more important for safety. It is particularly true at the airports from which both air carrier and private aircraft operate, where a wide variation occurs in operating speeds.

There are three major programs in the plan to deal with the problems of terminal area safety and congestion. They include the installation of additional towers and further automation of air traffic control at certain major terminals, and the provision of radars at other busy terminal locations.

FAA research and development programs exist to conduct a balanced research, development, test, and evaluation program to modernize the air traffic control system and develop those automation systems that will apply to the terminal and enroute programs.

Air Navigation

The higher maneuvering speed and larger mass of jet aircraft increasingly discourage any low altitude maneuvering for landing which is based upon visual reference to the ground. A substantial increase in the number of Instrument Landing Systems (ILSs) installations is required across the country. The costs incurred by aircraft diversions and delays due to meteorological conditions below prescribed minimums, and the necessity in any event to develop ultimately more highly automated systems of aircraft approach and landing, call for programs to improve the ILS and its associated facilities to increase the capability for low visibility landings. Within the next decade, the FAA will continue to explore the specific needs and the technology for replacement of the ILS. The safe and efficient use of the airspace, particularly in terminal areas, will require higher orders of precision than are currently provided and development of a "next generation" system, must be initiated. Distance measuring equipment located at ILS sites serves to improve the operational flexibility of traffic control and navigation, and enhances safety. When helicopter and other steep gradient aircraft provide scheduled service to new city centers under instrument conditions, navigation and instrument approach facilities will be required.

Communications

To provide additional capacity for aircraft flight in the National Airspace System, it has been necessary for the FAA to divide the airspace into an increasing number of control jurisdictions, each of which requires its own

discrete communications channels. With the advent of radar and direct pilot-controller communications, aircraft navigation and aircraft separation have, along with increased traffic volume, resulted in increased use of radar vectoring and, accordingly, increased communications. The result has been congestion of air-ground communication circuits which in some areas has reached critical proportions. The safety of the new and faster aircraft coming into greater use, and the economic penalties attributable to aircraft delays will require more rapid air-ground communications and an end to protracted voice communications with aircraft.

An effective air traffic control system will continue to be dependent upon the reliability of communications. To provide this reliability during the next ten years, a flexible, high-speed electronic rather than mechanical voice switching system will probably be required. As the air traffic control automation program is implemented, digital data transfer of radar information becomes possible with concomitant improvements in redundant coverage and economy.

Aviation Weather and Other Supporting Services

The safety of aircraft in the airspace is dependent in large part on pilots and traffic controllers being provided with accurate and pertinent aviation weather information, and aeronautical chart and flight information. The expected growth of air traffic and the introduction into transport service of larger and faster aircraft will require an extension of the present FAA operating and R&D programs for these traffic support services. More precise assessment is needed of the kinds and amounts of weather information required by particular segments of civil aviation, and by new kinds of aircraft, in the more automated traffic control system and structured airspace of the next ten years.

It will be necessary to continue research and development in cooperation with industry and the academic community on such problems as clear air turbulence and terminal area visibility. Special attention will also be required during the next several years to meet the growing demands of civil aviation for additional, precise and timely information on air facility status, topography and flight hazards, and other navigational information important to the safety of visual and instrument flying.

A major investment is required for FAA aircraft and equipment and R&D facilities at NAFEC. Capital expenditures will be required for these important items to support the agency's flight inspection and R&D programs.

Airports.

Air traffic congestion is a problem which is most critical at the terminal airport areas, and particularly the large metropolitan areas. Insufficient airport capacity during peak traffic periods is a major cause of aircraft delays. Passengers are delayed additionally by inadequate terminal facilities as well as inadequate airport access at many existing airports. The safety of aircraft and air travelers at the nation's airports is less extensive a problem, but the risk of accidents can be expected to rise if traffic increases and the airports are inadequate.

The airport as a vital element of the National Aviation System is recognized as one of the controlling factors in the achievement of maximum system capacity. The interrelationship between the airport and the air traffic control/navigation subsystems is such that balanced airport development and electronic equipment implementation is essential.

Unlike the air traffic control, navigation, communications, weather and data acquisition subsystems which are the responsibility of the Federal Government to install, operate and maintain, the airport is the responsibility of local authorities. The role of the Federal Government in the airport picture is, therefore, primarily one of predicting the nation's airport requirements; integrating planning efforts; encouraging development; providing technical, and to the extent authorized, financial assistance; establishing airport standards; and enhancing the safety and the efficiency of air traffic movement. This is accomplished through Airport System Planning; Airport Standards; and Airport System Implementation. Estimated new and existing airport development and expansion in the ten year span FY 1970-79 is $8.4 billion.

Airways Cost Allocation Study.

Since 1926 the Federal Government has provided, maintained and operated, for use by all categories of aircraft operators, both civil and military, a national system of air traffic control, flight advisory services, and aids to air navigation, together with a network of communications essential to the functioning of the system.

The annual expenditures for this system -- customarily called the Federal airways system -- are substantial, and for the fiscal year 1969 will exceed $700 million. Larger annual expenditures in the future will be needed to improve, expand and operate the system to meet the demands of a rapidly growing civil aviation. Because the existing fuel and air travel taxes do not provide revenues sufficient to cover the civil users share of the costs of the airways system, the Administration has proposed new and additional taxes to be effective with the new fiscal year.

As civil aviation continues to grow, it is evident not only that the airways system costs will continue to increase but, also, that the system's use and services will change in terms of individual categories of aviation. It is important, therefore, that cost allocations among the various beneficiaries be reviewed for their long term equity and applicability.

To accomplish this purpose, the FAA proposes to organize, with the advice and counsel of the aviation community, a comprehensive study, to be conducted over a period of approximately 15 months, on the subject of airways system cost allocation. The study will examine the relevant issues, develop a theoretical and conceptual framework for analysis, and recommend a methodology to provide the most equitable, economically efficient, and otherwise appropriate in terms of national objectives and total national welfare, cost allocation by the Federal Government of the services and facilities comprising the Federal airways system.

Among the tasks to be included in the study effort are the following.

1. Examine in the light of economic principles, other public policy guidance, and national objectives, the theoretical and conceptual aspects of defining relevant costs and allocating cost responsibility for the services and facilities comprising the Federal airways system.

2. Develop a methodology for allocating the costs of airways system facilities and services based on the guidance developed in the theoretical and conceptual phase of the study. This methodology must be feasible in terms of reasonable administrative workload and costs to the FAA annually, and realistic in terms of the existing institutional environment and Federal Government responsibilities in the subject area of civil aviation as set forth in existing legislation.

3. Survey the traffic statistics and other available data indicators of airways system use, and devise a statistical reporting program to obtain any additional data needed to effect the airways system cost allocation in the manner called for by the theoretical and conceptual phase of the study.

CHAPTER 3. DEFINITIONS AND ABBREVIATIONS

National Aviation System: The physical complex of civil airmen, aircraft, airports, airspace, airways, and facilities, and the services, regulations, plans, standards, procedures, and practices associated with the complex including system components jointly shared with the military. It encompasses the National Airspace System, the National System of Airports and the Federal Aviation Regulation System, as defined below. It does not include that part of the system operated by the military for military use only.

National Airspace System: The common network of U.S. airspace, navaids, communications facilities and equipment, air traffic control equipment and facilities, aeronautical charts and information weather information, rules, regulations, procedures, technical information, FAA manpower and material, and includes system components jointly shared with the military.

National System of Airports: The network of public use airports which serves civil aeronautics.

Federal Aviation Regulation System: The whole of rules, regulations, standards, or system characteristics promulgated by the FAA to which adherence is necessary in the interest of safety, regularity or efficiency of the National Aviation System.

System: In its largest sense and as used most in this plan, a system is an aggregate of functions and components comprising a significant operation such as the airspace system, airport system, etc. Within a system, there are major subsystems of the whole, such as the communications system. Many subsystems are loosely referred to as systems throughout the plan.

National Aviation System Plan: An action document which contains a description of the goals, requirements and criteria for the National Aviation System and a ten year resource investment schedule. These items exclude system components of pure military application.

System Requirement: An identified need which is to be fulfilled if safety standards are to be maintained and foreseeable aviation growth accommodated.

System Description: A narrative description of the method by which the agency elects to fulfill the requirement, whether it be hardware, procedures, regulations, or a combination of these.

System Goal: The expected results to be attained within the period of the plan.

Criteria: The minimum level of aeronautical activity or other bases which must exist for specific subsystems to qualify for implementation.

Facility: As normally used it is an aggregate of equipment and services comprising an operating entity at a specific location such as an air traffic control facility. In some instances a facility may consist of equipment without services. As generally used in the plan the term refers to facilities owned and operated by the FAA, but in some cases also includes facilities jointly owned and shared with military, state, or local authorities.

Location: Geographical position of a facility.

Equipment: Normally refers to the actual hardware or device which performs an aeronautical function. Often used as a synonym for facility.

ABBREVIATIONS

ACC	Air Coordinating Committee
ACIC	Aeronautical Chart and Information Center
ADC	Air Defense Command
AFB	Air Force Base
AFS	Aeronautical Fixed Service
A/G	Air/Ground
AGL	Above ground level
AFTN	Aeronautical Fixed Telecommunication Network
AIA	Annual instrument approaches
AIM	Airmen's Information Manual
AIO	Annual itinerant operations
AIRAD	Airmen Advisory
AIRMET	Airmen's Meteorological Information
ALS	Approach light system
AME	Aviation Medical Examiner
A/N	Alpha Numerics
ANF	Air Navigation Facilities
APC	Area Positive Control
ARC	Appalachian Regional Commission
ARSR	Air route surveillance radar
ARTCC	Air Route Traffic Control Center
ARTS	Advanced radar traffic control system (terminal)
ASDE	Airport surface detection equipment
ASR	Airport surveillance radar
ATC	Air Traffic Control
ATCRBS	Air traffic control radar beacon system
ATCT	Airport Traffic Control Tower
ATIS	Automatic terminal information service
AWLS	All weather landing system
CAA	Civil Aeronautics Administration
CAB	Civil Aeronautics Board
CARF	Central Altitude Reservation Facility
CAS	Collision avoidance system
CAT I, II, III	Landing Minima Categories
C&GS	Coast and Geodetic Survey
COMLO	Compass locator
COMVAN	Communications van

CONUS	Continental United States
CPA	Continuous power airport
CSC	Civil Service Commission
CS/T	Combined station/tower
CVF	Controlled visual flight
DARTS	Digital azimuth-ranging-tracking system
DME	Distance measuring equipment
DOD	Department of Defense
DOT	Department of Transportation
EDA	Economic Development Act
ERS	Expanded radar service
ESSA	Environmental Science Services Administration
EVS	Electronic voice switching
FAA	Federal Aviation Administration
FAAP	Federal-aid Airport Program
FAR	Federal Aviation Regulation
FAAR	Federal Aviation Administration Requirement
F&E	Facilities and Equipment Appropriation
FDP	Flight data processing
FL	Flight level
FPM	Federal Personnel Manual
FSS	Flight Service Station
FY	Fiscal Year
GA	General Aviation
GNP	Gross National Product
GPO	Government Printing Office
HDTA	High density terminal airspace
HF	High frequency
HVR	Helicopter visual range
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
IFSS	International Flight Service Station
ILS	Instrument landing system
IOC	Initial operating capability

ITU	International Telecommunications Union
LDIN	Lead-in lighting system
LAWRS	Limited aviation weather reporting service
L/MF	Low medium frequency
LORAN	Long range navigation
LRR	Long range radar
MALS	Medium (intensity) approach light system
MEA	Minimum enroute IFR altitude
MOPTAR	Multiple object phase tracking and ranging system
MSL	Mean sea level
MTI	Moving target indicator
NAFEC	National Aviation Facilities Experimental Center
NAP	National Airport Plan
NAS Stage A	National airspace system enroute automation program
NASPO	National airspace system program office
NASA	National Aeronautics and Space Administration
NFDC	National Flight Data Center
NMSS	National Meteorological Service System
NOA	New Obligational Authority
NOSUM	NOTAM summary
NOTAM	Notice to airmen
O&M	Operations and maintenance appropriation
PICAO	Provisional International Civil Aviation Organization
PONYA	Port of New York Authority
PVOR	Precision VOR
PWI	Proximity warning indicator
RAIL	Runway alignment indicator lights
RAPCON	Radar approach control facility (civil-military)

RATCC	Radar air traffic control center (civil military)
RCAG	Remote control air/ground communications
REIL	Runway end identification lights
RTR	Remote transmitter receiver
R&D	Research and development
RML	Radar microwave link
RVR	Runway visual range
SIGMET	Significant meteorological information
SPANAT	Systems Planning Approach North Atlantic
(S)SALS	(Simplified) short approach light system
SEAL	Signal evaluation airborne laboratory
SRV	Slant range visibility
SST	Supersonic transport
Stage A	En Route automation program
STOL	Short takeoff and landing
STRACPS	Surface traffic control system
TACAN	Tactical air navigation
TAIR	Terminal area instrument range
TRACON	Terminal radar approach control facility
TVOR	Terminal VOR
TWEB	Transcribed weather broadcast
TVR	Terminal VOR
UHF	Ultrahigh frequency
UPS	Uninterruptible power systems
USCG	United States Coast Guard
VASI	Visual approach slope indicator
VFR	Visual flight rules
VHF	Very high frequency
VOR	Very high frequency omnirange station
VORTAC	Co-located VOR and TACAN
VOT	VOR test signal
V/STOL	Vertical/short takeoff and landing
VTOL	Vertical takeoff and landing
WIP	Work in Progress
WMSC	Weather Message Switching Center

BOOK 1
1/27/69

PART II - PLANNING FORECASTS

PART II. PLANNING FORECASTS

CHAPTER 1. FORECASTS OF AVIATION DEMAND

SECTION A. METHOD AND PRACTICE

1. Introduction.

It is the increasing amounts and more complex mixtures of air traffic in the United States, generated by an expanding economy, improved civil aviation aircraft, and a changing technology which creat the need for further development of the National Aviation System. This chapter presents the more significant changes and developments which can be expected over the next ten years in the national economy, air traffic, and aviation technology.

Forecasting attempts to present information and data upon which long range plans can be based. Predicting the future is always a difficult and risky undertaking. This is particularly true when, as in the situation today, important changes taking place appear to be due in part to temporary and unusual circumstances. Separating the long-term and underlying trends from the short term fluctuations requires special care.

Quantitative forecasts are needed to guide long-range planning, nonetheless. The usual procedure of forecasters in accounting for uncertainty is to present the outlook in term of ranges -- high and low forecasts, for example. However, the demand forecasts presented in this chapter provide a single estimate for each statistical series to indicate the likely amount of activity. But this simplification of the presentation should not be taken as an indication that the forecasts are precise and not subject to a range of uncertainty. It should be noted too that the traffic forecasts represent estimates of unconstrained demand which sume the availability of an aviation facilities system and a safety regulatory environment which will permit realization of the anticipated traffic growth.

The section on the traffic outlook is followed by a discussion of the aircraft and aircraft systems technology in the 1970-1979 time period.

2. FAA Forecasting Cycle.

As part of its continuing planning process, the FAA annually prepares forecasts of key indicators of national aviation activity and of FAA operational workload. These forecasts are summarized and published in a report entitled "Aviation Forecasts" which is distributed throughout the agency and upon request to the aviation community.

The forecasts cover a 10-year period. Specific numerical forecasts are prepared for each of the first five forecast years to meet the short-term needs of budget, fiscal, and program planning and to provide forecasts required in the preparation of the FAA Five-Year Program. Ten-year forecasts of each series are also developed to meet longer-range planning needs.

The forecasting effort is a continuing program - in the annual cycle each forecast series is reviewed and revised as appropriate in the light of developments during the past year and extended one year further into the future. In addition, FAA closely monitors certain forecasts which are of particular concern for short-term budget and operational planning by comparing their performance with actual results each month and semi-annually prepares revised forecasts of these series as appropriate for the ensuing two years.

FAA also prepares a variety of special forecasts to meet varying planning needs of the agency. These include studies of regional and local airport activity, peak period traffic forecasts, North Atlantic traffic, Washington area airport traffic, and airmen statistics.

SECTION B. METHODOLOGY AND ASSUMPTIONS

1. Air Carrier Forecasts.

Various methodologies and techniques are utilized by the FAA in developing its forecasts of aviation activity and FAA operational workload for each segment of aviation. In large part the approach is determined by the currency and completeness of the available data base. Because air carrier aviation is well documented, more sophisticated forecasting techniques can be utilized than are possible in the area of general aviation. The forecasts are shown in a series of tables in Section C of this chapter.

The forecasts of air carrier aviation begin with a forecast of total U.S. domestic revenue passenger-miles (Table II-1). The latter is derived from a methodology which relates total passenger revenue, including the air travel tax, Gross National Product (GNP), and the overall revenue yield per passenger-mile. In preparing the forecast, a long-term annual average GNP growth rate, in constant 1958 dollars, of 4.25 percent was used. This rate was decided upon after a review of various GNP forecasts made by non-government organizations and after discussions with certain Government economists. The forecast also assumes a continued downtrend in passenger-mile revenue in 1958 dollars of three percent per year; in current dollars the decline in yields is not expected to exceed one percent per year. The projection of future yields was based on judgment which considered the history of the domestic fare structure, the future fleet composition, and anticipated changes in aircraft cost and performance characteristics.

The forecast of U.S. international revenue passenger-miles (Table II-1) is related to the forecast of U.S. domestic passenger traffic. Historically, there has been a very close relationship between the amounts of passenger revenue received by the U.S. international carriers and the U.S. domestic carriers. The forecast assumes this relationship will continue and international passenger revenue was forecast at 28 percent of the domestic revenue, or about the same level it has been for the past 15 years. (Because of the pending status of route awards in the Pacific area, it was not possible to account for their impact on the forecasts presented herein. The new routes and additional service will certainly increase U.S. international air carrier traffic, but by how much has not yet been determined.) The passenger-miles were determined by dividing the revenue by a passenger-mile yield. The latter has been declining in absolute terms and also in relation to the domestic yield and was forecast at about 88 percent of the domestic yield.

The forecasts of domestic and U.S. international passenger enplanements were derived by dividing the forecast passenger-miles by an estimate of the average passenger trip length.

The forecast of the U.S. air carrier fleet (Table II-2) was based on a review and analysis of the individual air carrier requirement. The base for the forecast was the number of aircraft, by type, each carrier had on hand and on order. The latter data was compiled from proprietary delivery schedules submitted to the FAA by the aircraft manufacturers as well as from public announcements of orders.

A carrier-by-carrier review was made of all the fleet information and additional estimated aircraft orders were assigned to certain carriers if their future fleets, as tallied, were deemed not adequate to handle normal traffic growth, provide for retirement of some aircraft types, and to maintain a competitive position with other airlines. Judgment based on trend values was used to project the individual carrier fleets by aircraft types beyond the years for which aircraft order information was available.

After the preliminary fleet estimates were prepared, a computer program was used to develop estimates of the fleet's total available seat-mile productivity to determine its consistency with the forecast of the revenue passenger-miles. A separate productivity determination was made for each type of aircraft based on average annual utilization, average block speed, and average passenger seats aboard each type of aircraft by carrier group. The procedure provided estimates for each year of total aircraft hours and miles flown and of total available seat-miles. The seat-mile estimates were then compared to the passenger-mile estimates previously prepared and tested for reasonableness on the basis of appropriate load factors. The computer model used to develop the fleet's total productivity has not only facilitated the handling of large quantities of data but has readily permitted sensitivity analyses of the basic assumptions and variables.

2. General Aviation Forecasts.

The limited amount of data available concerning general aviation flying has precluded the use of a forecasting model. The forecasts of total hours flown in general aviation and the number of active general aviation aircraft represent the sum of separate forecasts made for each of the major segments of general aviation, i.e., business, personal, instructional and commercial flying, and for each type of aircraft. Each use category was projected statistically and the results adjusted, as appropriate, on the basis of other available data, anticipated developments, discussions with and comments received from the general aviation community.

3. FAA Workload Forecasts.

The forecasts of the various FAA operational series (Tables II-3 - II-5) represent the sum of separate forecasts of air carrier, general aviation, and military activity. Air carrier aircraft operations were forecast by doubling the estimated number of departures. The number of departures

was determined by dividing the forecast aircraft miles flown by appropriate estimated average stage lengths for each aircraft type in the air carrier fleet. The average stage lengths by aircraft type were based on an examination of past trends modified to reflect expected changes in the future use of particular aircraft types. Air carrier enroute IFR traffic was then forecast based on projections of its relationship to total air carrier aircraft operations.

The estimates for military air traffic activity were based on analyses of past trends plus a review of fleet and flight hour activity provided by the Department of Defense. General aviation operations were forecast based on a trend analysis of historical data as well as data developed in a special study on general aviation prepared in 1966. The operations forecasts also took into account new tower installations planned for the forecast period.

SECTION C. AVIATION FORECASTS, FISCAL YEARS 1970-1979

1. The National Economy.

The nation's Gross National Product (GNP), family incomes, employment, and business and industrial activity are all firmly established in long-term upward trends and provide the base for a surging growth in civil aviation. From 1950 to 1967 GNP rose from $355 billion to $673 billion, in constant 1958 dollars -- an increase of 90 percent. By 1979 GNP is expected to grow to $1,079 billion (in 1958 dollars), a further increase of 60 percent. Since national income is expected to increase more rapidly than the size of the population and the work force, family incomes and the standard of living will rise for a growing number of persons. From the standpoint of aviation demand, it is particularly significant that families with incomes of $10,000 or more will be approximately twice the 1960 level by 1979.

Other changes, having important implications for aviation growth, are expected in the size, composition, and the geographic distribution of the population. Between 1950 and 1967 the population of the U.S. rose from 152 million to 199 million. By 1979 the population will total an estimated 235 million -- an increase of 36 million persons.

Shifts in the geographic distribution of the nation's population will reflect the trends already in evidence. Population growth is expected to be most rapid in the Pacific States and in the South Atlantic States in response to the increased industrialization of these areas.

By 1979 over half of the population will be living in the 30 largest standard metropolitan statistical areas having a population of 1,000,000 or more each and an additional 25 percent will reside in the remaining SMSA's.

The size of the civilian labor force will increase from about 76 million in 1967 to 97 million in 1979. From the standpoint of air transportation, expected changes within the work force will have significance. The work force of the future will consist of a rising proportion of well-educated and more highly trained managerial, service, and technical personnel each having a high travel propensity and an increasing need for expedited means of travel.

2. Airline Passenger and Cargo.

Continued high growth rates in passenger traffic are forecast for the next ten years for both the United States domestic and international air carriers. By fiscal 1979, the U.S. airlines are expected to fly a total of 429 million passengers and 342 billion revenue passenger-miles in scheduled domestic and international service. These figures compare with 153 million passengers and nearly 107 billion revenue passenger-miles in fiscal year 1968.

The number of domestic revenue passenger-miles is expected to increase sharply over current levels. In fiscal year 1968, domestic scheduled airlines flew 81.6 billion revenue passenger-miles. By 1974 this volume will increase by 90 percent, and by 1979 it will climb to 260 billion revenue passenger-miles, over three times the 1968 total.

In fiscal year 1968, U.S. international airlines carried 15 million passengers for a total of almost 25 billion passenger-miles. By 1979, these volumes are expected to reach totals of 45 million passengers and 82 billion passenger-miles.

Table II-1

U.S. SCHEDULED AIRLINE PASSENGER TRAFFIC

Fiscal Year	Revenue Passengers Enplaned (millions)			Revenue Passenger-miles (billions)		
	Total	Domestic	Int'l.	Total	Domestic	Int'l.
1962	66.6	59.9	6.7	42.5	33.0	9.5
1968	152.6	137.5	15.1	106.5	81.6	24.9
1974	269.5	241.5	28.0	204.0	155.0	49.0
1979	429.0	384.0	45.0	342.0	260.0	82.0

Air cargo is also expected to grow rapidly. An average annual growth in air cargo in excess of 20 percent is anticipated. This means that by 1975, U.S. domestic and international air carriers should be flying about 20 billion ton-miles of express, freight and mail compared to 5.0 billion ton-miles in 1967.

3. Air Carrier Fleet.

To handle this growth in passenger and cargo traffic, U.S. air carriers are forecast to increase their aircraft fleet from 2,452 aircraft at the beginning of 1968 to 3,480 aircraft at the start of 1979. During this period, U.S. air carriers will shift to a predominantly jet aircraft fleet as the number of jets increases sharply from 1,344 in 1968 to almost 3,200 in 1979. Conversely, piston aircraft will be virtually phased out of service with the possible exception of a limited number in domestic operations on shorter-range, low-density routes, and in non-scheduled service.

Stretched versions of current four-engine jet transports are expected to be in increasing demand. The number of two and three-engine jets will increase substantially throughout the forecast period -- from 638 in 1968 to 1,636 in 1974 and to 2,422 in 1979. Included in these numbers are "standard" and "stretched" versions of today's models as well as substantial numbers of large capacity "airbus" models. The larger, four-engine "jumbo" jet seating up to 380 passengers is scheduled to enter service in fiscal 1970. It will be used initially on high-density long-haul passenger routes and gradually replace the current four-engine types.

Service with the Concorde by U.S. airlines is expected to begin in 1972/74 and U.S. SST service is expected to begin in 1977/78.

Through the forecast period, growing industry and government attention will be directed to the V/STOL and STOL aircraft. However, they will probably not be in active operation in any significant number during this period.

Table II-2

TOTAL AIRCRAFT IN SERVICE OF U.S. AIR CARRIERS AS OF JANUARY 1

Aircraft Type	1966	1968	1974	1979
Total Aircraft	2,125	2,452	3,050	3,480
Fixed-wing	2,104	2,430	3,027	3,432
Jet	725	1,344	2,545	3,158
Turboprop	312	444	321	234
Piston	1,067	642	161	40
Helicopters	21	22	23	48

Note: Included are all passenger and cargo aircraft owned or leased by, and in the domestic or international service of the U.S. certificated route, supplemental, intrastate and commercial air carriers. For 1966 and 1968 reported data are shown.

4. General Aviation.

General aviation activity has been expanding rapidly and the outlook is good for continuation of this growth. At the beginning of 1968, there were approximately 114,000 active general aviation aircraft. This number is expected to increase to 162,000 by 1974 and to 205,000 by 1979.

A sharp increase in turbine-powered general aviation aircraft is anticipated. By 1974, the number forecast is 3,8?0 and by 1979 they will total 7,000. Comparatively, there were 1,281 in the active fleet at the beginning of 1968.

Business flying will remain the largest type of general aviation flying. Air taxi, personal, and instructional flying will show sizeable increases by 1979.

5. Air Traffic Activity and FAA Workload.

The great expansion anticipated in air carrier and general aviation activity will result in significant increases in airway and air traffic workload handled by FAA facilities. The following outlook is projected for various measures of air traffic activity and workload at FAA terminal and en route facilities.

Total aircraft operations at airports with FAA traffic control service will rise from 53 million in fiscal year 1968 to 94 million in 1974 and 155 million in 1979. Most of this gain will result from increasing air carrier and general aviation flying at airports already provided with FAA tower services. Part of the gain, however, will arise from the installation of new towers at locations where traffic growth meets the tower establishment criteria.

Itinerant aircraft operations are forecast to almost triple between fiscal years 1968 and 1979 as the volume climbs from 32 million to 91 million. General aviation will account for nearly 80 percent of the itinerant operations in 1979 compared with 65 percent in 1968.

Air carrier operations showed little change between fiscal years 1957 and 1963. The greater seating capacity of the then new large jet aircraft and the higher density seat configurations associated with the increasingly important coach/economy service, made it possible to handle more and more passengers without increasing flight schedules. However, air carrier operations began to rise in 1964. Further rapid increases in operations are expected in order to meet the needs of expanding passenger and cargo service. This will be true despite the continuing introduction into service of larger transport aircraft, e.g., stretched jets, jumbo jets and the supersonic transport (SST).

Table II-3

AIRCRAFT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE
(in millions)

Fiscal Year	Total	Itinerant	Local
1962	27.4	18.8	8.6
1968	53.0	32.4	20.5
1974	94.2	55.8	38.4
1979	154.5	90.7	63.8

Instrument operations at airports with FAA traffic control service (including those at FAA-operated military radar approach control facilities) totaled 14.6 million in fiscal year 1968. The FAA forecast calls for 28.8 million in fiscal year 1974 and 44.5 million in fiscal year 1979 as an increasing proportion of air carrier and general aviation operations are flown under instrument flight rules (IFR).

Table II-4

INSTRUMENT OPERATIONS AT AIRPORTS WITH FAA TRAFFIC CONTROL SERVICE
(in millions)

Fiscal Year	Instrument Operations
1962	7.4
1968	14.6
1974	28.8
1979	44.5

The number of IFR aircraft handled, which is used to measure en route IFR activity and workload at FAA air route traffic control centers, is forecast to increase from 18 million in fiscal year 1968 to 41 million in fiscal year 1979. This assumes 20 en route traffic control centers in the contiguous United States and present-day operating rules and procedures.

Table II-5

IFR AIRCRAFT HANDLED BY FAA AIR ROUTE TRAFFIC CONTROL CENTERS
(in millions)

Fiscal Year	Total	Air Carrier	General Aviation	Military
1962	10.1	5 5	0.9	3.7
1968	18.1	10.8	2.8	4.5
1974	29.1	17.6	6.9	4.6
1979	41.4	22.0	14.9	4.5

Note: Detail may not add to total due to independent rounding.

6. Traffic Demand at Major Air Commerce Airports.

The great expansion in overall U.S. air traffic expected in the next ten years will result in tremendous increases in the demands that will be placed on individual U.S. airports. This is especially true of the principal air carrier airports in the large air traffic hubs.

Historically, U.S. commercial air traffic has been highly concentrated. In 1965, the 21 1/ major U.S. metropolitan areas accounted for 66 percent of total airline passenger enplanements and 48 percent of all air carrier operations at U.S. airports. Moreover, as a group, these large air traffic hubs have increased their share of the total air traffic. By 1970, it is anticipated that they will account for approximately 70 percent of all airline passengers enplaned in the U.S.

1/ The New York Standard Consolidated Area was considered as one community as was the Washington/Baltimore complex.

In 1965, only three large air traffic hubs generated more than 6,000,000 enplaned passengers -- New York, Chicago and Los Angeles. By 1980, twenty of the twenty-one large hubs (all except Cincinnati) are expected to generate more than 6,000,000 enplaned passengers annually.

The great expansion expected at these key air carrier airports makes it clear that solutions to the problems of capacity, congestion, and delay will become increasingly more pressing. The bulk of air carrier delay is concentrated at a few airports. An FAA study indicates that air carrier terminal delay during calendar year 1966 at 304 terminal areas served by FAA towers amounted to 173,000 hours and that the cost of this delay to domestic air carriers alone was about $57 million. Of these system totals, 35 high-activity airports accounted for 72 percent of the delay and its associated cost.

Significantly the top seven airports, ranked by delay, accounted for 51 percent of the nationwide total. These airports were J.F. Kennedy 18 percent, Chicago O'Hare 12 percent, LaGuardia 6 percent, Newark 4 percent, Atlanta 4 percent, Washington National 4 percent, and Los Angeles 3 percent. These same seven airports accounted for 25 percent of the air carrier operations handled by FAA towers located in the conterminous United States and 35 percent of the domestic airline enplaned passengers. Thus, it is clear that aircraft operations, passengers, and delay problems are concentrated in a relatively few airports and it follows that additions to capacity at these locations will have the most significant benefit.

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CHAPTER 2. AVIATION TECHNOLOGY FISCAL YEARS 1970-1979

SECTION A. AIRCRAFT AND AIRCRAFT SYSTEMS

1. Summary.

The air carrier fleet during this ten-year period will see the introduction of the jumbo jet, the airbus and the supersonic transport together with improved VTOL and STOL aircraft. General aviation will continue its rapid growth in an evolutionary manner with new structural concepts being introduced. This chapter presents some of the salient technological features of the aircraft and aircraft systems that will be produced to handle the growth in air travel that is forecast for the 1970-1979 time period.

2. Subsonic Transport Aircraft.

Present subsonic jet transports now operational and those being developed for immediate future service should fulfill many of the air transportation requirements for the decade 1970-1979. Many of the present four-engine jet subsonic transports now being utilized were introduced into service about 1958. Only minor airframe improvements have been made in these aircraft with the most significant technological advances achieved in the propulsion systems.

The airbus and jumbo jet type transport aircraft scheduled for introduction in the early 1970's will, of course, meet the requirement to transport large numbers of people between large metropolitan areas. No great changes in the air traffic control system, including the airports, will be necessary to accommodate these aircraft. The only exception to this will be the terminal building area of the airport which will be required to handle large numbers of people at one time.

Considering the already crowded condition of today's larger airports, major terminal facility improvements are required if the real economic potential of jumbo jets are to be fully realized. Adequate ramp space docking or gate facilities and ground servicing capability must be provided. The fuel capacity of the B-747 of approximately 372,000 pounds is double that of the 707-320B. Efficient handling of the maximum passenger payload of from 366 to 490 passengers with their baggage will require changes in passenger handling facilities and procedures at many terminals. The freighter configuration, with cargo loads of up to 220,000 pounds, will require increased terminal capability for loading, unloading and transportation to peripheral storage facilities.

Statistics on the Boeing 747, are as follows:

Maximum Gross Weight	710,000 lbs.	
Maximum Takeoff Thrust/Engine	43,500 lbs.	
Length Overall	231 ft.	
Wing Span	196 ft.	
Cruise Speed (Mach No.)	.85	
Mean Cruise Altitude	35,000 ft.	
Payload/Range	Passenger	Freighter
	Max. Pass. & Cargo 143,000 lbs./3450 S.M.	Max. Cargo 220,000 lbs./2650 S.M.
	85/15 Mix of 366 Pass. 73,000 lbs./5500 S.M.	110,000 lbs./5500 S.M.

It does appear, however, that during this period a greater need will exist for short haul air transportation between small metropolitan areas or between small communities and metropolitan centers. The number of people requiring such transportation will not require the use of the airbus type transport nor would it be economically feasible. Therefore, it is quite probable that by 1977 or 1978 there will emerge a subsonic jet transport aircraft designed for short stage lengths with performance capability to operate on short runways with passenger capacity of 40 to 60 persons.

Technological advances to meet the requirements of such an aircraft and to improve the performance of existing transports will be made.

In aerodynamics, progress will be made towards increased lift, decreased drag and improved stability and control. Additional productive research will result in increased noise compatability of aircraft, as well as reduced air pollution.

In the propulsion area advanced structural concepts, for example, compressor materials that permit higher allowable stress levels, will result in significant improvement in thrust to weight ratio. Improvement in compressor blade design, such as the use of slotted airfoils, and in cooling technology will permit significant increases in propulsion system thrust.

In this period of time new fuels will likely be produced and utilized. Experimentation is now taking place with methane and hydrogen. This effort is dictated by the need for more efficient and economical fuels. Also, this decade may see the experimental application of nuclear power to air transportation.

Technological advances in airframes such as plastic honeycomb materials and boron carbon filaments will produce greater strength, efficiency and dependability. New airframe design and structural integrity will enhance egress of passengers in the post-crash environment.

Human factors knowledge will play a vital role in air transportation during this period. Enlightened methods of measuring pilot and crew-member performance, stress level and potentiality will be utilized. Results of such technology will be evident in aircrew-aircraft environmental compatibility, instrument and control design, etc.

3. Supersonic Transport Aircraft.

The introduction of the SST into airline service requires the consideration of some new or different performance characteristics and design features in order to assure operations environment compatibility. Line maintenance considerations may involve new approaches due to the size of these aircraft, the size and complexity of the propulsion systems, the evolution of airborne integrated data systems in support of maintenance, and evolution of other items usually associated with line maintenance. Ground support equipment is not expected to pose any greater problem than was experienced in providing subsonic jet ground support, but larger tow equipment can be projected into tomorrow's jumbo jet operation as well as for the SST. Passenger terminal facilities and turn-around servicing will require expansion to serve jumbo jets and, therefore, relatively slight additional considerations to serve the SST.

Flight dispatch procedures for supersonic aircraft will probably demand computer aided planning and flight following capabilities for precise operational control. Considering the projected traffic density in terminal operating areas for 1976, and the critical nature of fuel consumption in SST operations, in order to minimize holding, it will be highly desirable to release a flight with reasonable expectation of no significant arrival delay. Weather forecasts need be projected only two to three hours, compared with four to eight today; however, greater accuracy is economically desirable. En route supersonic operating altitudes, in the foreseeable future, are not expected to be as densely occupied as today's jet operating altitudes, but projections of high altitude airspace

occupancy must be made on a continuing basis. One added constraint to the dispatch of SST flights, the extent of which is not yet fully determined, may be imposed because of sonic booms. In any event, the transonic phases (during climbout and after cruise) will demand precise programming and control.

For terminal departure the jumbo jets and SST may be towed to a clear area for engine start. Taxiing in the larger SSTs will be aided by a television system since gear position and movement on taxiways will be relatively difficult to judge from the flight deck, which is as much as 60 feet forward of the nose gear and 175 feet from the main gear. Some taxiway intersection fillets may require enlarging. This also requires development of new ground handling units.

The SST engines are sized for the thrust needs of transonic acceleration giving a sustained rate-of-climb capability after takeoff significantly higher than experienced in today's subsonic jet operations. Noise restrictions and high rates of fuel consumption will demand careful attention to departure operating procedures. Automatic guidance and control will be available throughout the operating envelope for climb, transonic acceleration, cruise, descent, approach, flare, touchdown, rollout and perhaps taxi turnoff.

Holding at supersonic speeds is not feasible. At subsonic speeds, holding will be extremely uneconomical, especially at low altitudes. While some provision for holding must be made, it must be held to the minimum. Rapid climb and descent give the most economical operation, but what will be possible in practice must be held consistent with operations of subsonic aeroplanes in the same airspace plus the limitations or restrictions imposed by sonic boom and powerplant noise. The supersonic transport will climb steeply at a high subsonic speed to altitudes of 25,000 - 40,000 feet. It will then reduce climb angle, apply full power, go supersonic and continue accelerating at a lower rate of climb until reaching initial cruise altitude and speed. Cruise climb or step climb may be employed with fuel burnout consistent with efficiency of operation and air traffic control.

Self-contained inertial navigation equipment will provide the primary means of en route navigation for the SST. En route navigation by means of the VORTAC system is inadequate at supersonic speeds, and its use by the SST will be limited generally to subsonic operations in the terminal areas. Ground based electronic facilities now installed for terminal area navigation are suitable for the SST. Additional work is necessary with regard to terminal facilities required for all weather landing.

At supersonic speeds the radius of practical turns will be very large. Sudden changes in course cannot be accomplished; therefore, it will not be possible, either, to avoid collision by the "see and be seen" principle except, possibly, in an overtaking case. Additional development of collision avoidance systems is necessary.

Because of the high cruising speed of the SST, flight time is affected very little by head or tailwinds. However, the effect of wind on fuel consumption will not be negligible. An unaccounted for 50-knot headwind on a 3-hour flight will be equivalent to extending the stage length by 150 nautical miles and approximately 8,500 lbs. of fuel. The SST will also be more sensitive to optimum altitude and temperature variations than subsonic aircraft. The effect of turbulence is still under investigation.

Neither solar and galactic radiation nor ozone concentration at SST cruise altitudes is expected to pose any threat or danger to crewmembers or passengers. In the rare event of a high energy major solar flare, for which there will be adequate warning, a flight may have to be cancelled, rescheduled, or follow a different route. Study of the likely effects of this phenomenon on SST flight will be continued.

The existing world-wide network of radiation monitoring and measurement facilities will have to be linked with operational dispatch facilities - probably through established Environmental Science Services Administration (ESSA) channels and ARTC facilities.

A step-cruise or cruise-climb phase for most SST flights will account for a little over half of the total block time. About 50 minutes will be taken for taxi, takeoff, and acceleration to climb speed, departure air maneuvers, acceleration and supersonic climb. About 30 minutes will be required for deceleration, descent, destination air maneuvers, landing and taxiing. Cruise phases depending on stage length and speed (M=2.2 or M=2.7) will run about 1:20 to 1:50.

In the U.S. SST, and probably to a large extent in the Concorde, crew workload during cruise will be different than in subsonic jets because of the auto-nav and automatic flight control systems. Due to the heavy reliance upon these automatic systems in all the phases of flight, crew tasks are expected to evolve into more of a management and monitoring function, as compared to today's operator role.

Air traffic separation procedures must take into account the flight profile, cruise altitude, and maneuvering restrictions inherent to SST operations. Fortunately, systems automation, redundancy, and high reliability, combined with new and better pilot information systems, will offset the impositions of speed, altitude, size and peculiar supersonic design features which will be new to the airline pilot. His workload then should neither increase nor decrease in the physical sense but rather shift toward monitoring tasks. The few added considerations peculiar to the SST flight environment pose no critical impositions on human performance capabilities. Nonetheless, efforts should be made to improve the air traffic control communication system to minimize the number of channel and frequency selections and required voice contacts.

"Autopilot" operation over a wider range of flight phases should reduce flight plan performance variations -- a feature which can be put to advantage in projecting accurate area arrival and touchdown timing. As in the cases of the preceding phases, descent, approach and landing are expected to be automated, but with the flight crew always in-the-loop to cope with abnormal or emergency contingencies. Because of the critical impact of abundant fuel reserves on payload, operating procedures sensitive to any holding or delays will be the major influence on the economic viability of [illegible] operation. Terminal airspace boundaries which were effectively moved outward for subsonic jets may have to be extended further yet for supersonic operations to accommodate assured runway acceptance.

4. STOL and VTOL Aircraft.

At this time, just prior to the 1970-1979 period under consideration, we find only one type of VTOL aircraft, the helicopter, and one type of STOL aircraft, the light, fixed-wing aircraft with high lift devices, in actual service. These are special use vehicles and do little to represent the potential of STOL and VTOL aircraft that will become available with advances in technology. Applying these advances, however, to these two classes of aircraft will require commitment of development funds by either civil or military sources. The rate at which this is done will determine the timing and the degree of impact of STOL and VTOL vehicles on the air transportation system during the 1970-1979 period. The potential economic advantages warrant extensive allocation of resources to such development.

Although all aircraft derive their lift by imparting a change of momentum to an air mass, STOL and VTOL aircraft accomplish this in a wide variety of design schemes, some of which are part of the forward propulsion system and some of which are separate. The degree to which this lift mechanism departs from fixed wing derived lift is a measure of the aircraft's STOL or VTOL capabilities.

STOL performance, with reduction in landing speed to around 60 knots, is achieved by increasing the wing maximum lift coefficient by high lift devices or by maintaining high local airflow velocity over the wing by means of the propulsion system or a combination of both. Examples of current aircraft of this type are the four-engine Breguet 941 with propeller deflected slip stream, the single-engine Helio and the Wren modified Cessna 182. In the transport category such as the Breguet, the requirements for high-wing loading for suitable cruise speeds and ride qualities conflict with the desire for low-wing loading in approach for gust speed margins with maximum lift coefficients around 4 or 5. The composite design that results can operate out of short fields and have reasonably attractive cruise performance for intercity operation. In multi-engine propeller designs, engine cross-shafting is required to prevent loss of control with one engine out. Other STOL design approaches being considered with turbofan propulsion include the use of blown flaps for increased lift or the addition of lift fans to supplement normal wing lift.

The gap between STOL approach speeds and VTOL performance will probably remain through the 70's because of economic reasons. Closing this gap to achieve slower STOL approach speeds begins to require the lift and control techniques of VTOL aircraft which are more sophisticated and costly so that the designer might as well go all the way and get VTOL performance.

Growth of STOL operations in the 70's will depend on the development both of aircraft and of STOL landing facilities at large airports and at local general aviation airports with expanded passenger handling capabilities. The general aviation airport of today will gradually become the air carrier airport of the future.

Greater emphasis has been and will be placed in VTOL development both by the civil and the military. The helicopter is here and with modification will continue to be the primary VTOL vehicle in the 70's. This vehicle will grow from the basic helicopter into the compound helicopter with a wing to unload the rotor in cruise for higher cruise speeds. The next step will be to stop the rotor in cruise and then finally to stop and

retract the rotor in cruise. Control problems caused by the lift assymetry of the slowly turning rotor before it stops will be severe as will the mechanical problems of stowing the rotor. It is doubtful that these more sophisticated helicopters will see operational use before 1979 although the compound helicopter could be in use by 1975 with cruise speeds of 250 knots.

The appea and efficiency of the helicopter's low disc loading is departed from in the other forms of VTOL aircraft such as the tilt wing and tilt duct propeller aircraft. Current examples are the Ling Temco Vought XC-142A and the Canadair CL-84 tilt wings together with the Bell X-22A tilt duct aircraft. Cruise speeds up to 400 knots are available with this class of aircraft. Although downwash velocities and ground erosion are reasonably low, the control system and engine power coupling problems are complex and result in a sophisticated aircraft requiring system redundancy since auto-rotation is not possible with power failure. It is doubtful that these aircraft will see use for passenger transportation in the 1970-1979 time frame.

Much more development effort must be done on the lift fan type of VTOL aircraft before these could become operational. Also, the lift jet engine plus cruise jet engine aircraft have the cost problem of the extra set of engines that mitigates against their economic commercial use during the next ten-year period.

5. General Aviation Aircraft.

General aviation aircraft will retain their current outward appearances throughout the 1970-1979 period. The increased use of this transportation mode for both business and leisure travel and the resultant growth in the aircraft population will place increasing demands on airport ground facilities and aircraft parking areas.

a. Aircraft Design and Manufacture.

New innovative structural designs will be introduced utilizing epoxy adhesives and fiberglass materials to produce shapes more readily obtained than with metal. These new construction concepts using molded structural parts with their attendant ease in assembly will be brought to the forefront.

There will continue to be an ever increasing need for low-cost, lightweight, two to four place aircraft for both primary training and leisure time flying.

Light, twin-engine aircraft, particularly those involved in commercial endeavors, will realize the greatest benefit from the new design and manufacturing methods by the late 1970's. Increased payload and performance advantages will reduce operating costs and provide this segment of the industry with a more favorable competitive position with regard to surface short haul transportation.

b. Propulsion.

New engine design concepts such as the rotating combustion engine will make their appearance in the early 1970's. New, light weight, more powerful turbo-prop engines will be introduced taking advantage of technological breakthroughs in new high strength materials. The simplicity of operation, construction, and economy of these new designs will have a marked effect on the aircraft engine industry by the end of this period.

The turbo-jet engine, while increasing in total numbers, will retain its present relative standing within the total aircraft engine population. Engines sized for adequate takeoff thrust and high subsonic cruise speeds dictate multi-engine sophisticated aircraft designs, useable primarily by industry for executive transportation.

c. Aircraft and Engine Systems.

Human factors will receive the greatest attention in the systems area. By the mid 1970's general aviation aircraft will have a variety of systems installed as standard equipment rather than optional as is now the case. Examples of this will be low-cost, light-weight stability augmentation devices to ease pilot workload and automatic gear retraction and extension systems to prevent inadvertent wheels-up landings. Greater emphasis will be placed upon the compatability of technological advances with human capabilities.

d. Navigation/Communications Equipment.

The avionics industry will continue to keep pace with the general aviation demand for expanded operation. Course line computers, Loran, and other navigation concepts will be available throughout this time period. However the size of the market demand during this period will be the main restraint to low cost purchases for general aviation.

6. Aircraft Systems.

Today's most accurate barometric altitude indicator can maintain an altitude level within 250 feet up to the maximum operating altitude of the controlled airspace. Controlled airspace includes sea level to 50,000 feet at the present time. The most accurate barometric altitude indication is that coming from an air data computer which is a device utilizing pneumatic and/or electrical pulses of pitot, static pressure and an electrical input of total air temperature. With these inputs the computer provides information as to pressure altitude, equivalent airspeed, Mach number and maximum operating speed, true airspeed, total and static air temperature. The greatest difficulty being encountered is in the sensor system for static pressure.

Present techniques of obtaining ambient pressure are available that provide a system accuracy requirement of ± 250 feet for the altimeter system considered necessary for reducing the vertical separation from 2,000 feet to 1,000 feet above flight level 290 (29,000 feet); however, many subsonic aircraft have static pressure systems that do not meet the necessary system accuracy.

The use of compensated pitot-static tubes will provide improved airspeed and altimeter ambient pressure and impact pressure information. The use of these tubes will be necessary on high subsonic and supersonic aircraft to eliminate large errors associated with present static port sensors. For flight above 50,000 feet, use of electronic means of maintaining flight level may be necessary. This may be accomplished by using navigation satellites or radio altimeters above ocean routes towards the end of the 1970-1979 period. Research efforts to reduce weather effects on such systems must be expanded.

For supersonic flight above flight level 500 (50,000 feet), separation standards must be increased due to the inaccuracy of the altimeter system at these altitudes. Automatic flight control appears to be necessary along with a collision avoidance system to assure safe flight at the presently assigned vertical separation standards (2,000 feet) in this airspace. All indicators must provide good reliability and easy readout.

Aircraft instruments will continue to be improved and many multi-engine aircraft will be equipped with vertical scale and digital readout instruments. The accuracy of these instruments would also enable pilots to fly IFR at reduced separation standards above flight level 290. Most of the general aviation aircraft would be capable of instrument flight

operations. In the subsonic airspace region (below 50,000 feet) the use of geopotential altitude will be continued whereas in the supersonic region (above 50,000 feet) use of height computers will enable geometric altitudes to be used for vertical separation. The use of navigation satellites will enable this means to compute geodetic altitude. This form of altitude measurement would be more accurate than presently available geopotential aneroid sensors.

In the early 1970-1979 period, many general aviation aircraft will be equipped with low-cost flight directors and horizontal situation displays. The flight director system provides a graphic presentation of navigational and attitude information and presents computed steering commands. These equipments will provide both accuracy levels and clarity of presentation necessary for Category II (100 feet ceiling - ¼ mile horizontal visibility) IFR operations for general aviation aircraft. It is anticipated that both mechanical and video display techniques will be used.

There will be available several low-cost, area navigation computers which will enable aircraft to fly off airways. These navigation systems provide airport to airport navigation with resulting timesavings and will aid in airway traffic congestion alleviation. These systems will see increased use in the 1970's in most general aviation aircraft which are in the $25,000 price range and above.

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BOOK 1
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PART III - AIR TRAFFIC CONTROL

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INTRODUCTION

The principal mission of the air traffic control system is to provide for the safe and efficient flow of traffic including the establishment and operation within the limits of available appropriations made by the Congress of the necessary air navigation and air traffic control facilities. In ... context of this mission the system is called upon not only to provide aircraft clearances and instructions to maintain safe separation between aircraft flying under instrument flight rules (IFR) but also to perform a variety of other services. Increasingly, the air traffic control system is providing advisory services for separating VFR and IFR traffic, disseminating meteorological information, assisting ... aircraft navigation, and participating in functions not related solely to aircraft separation.

This part deals with requirements, descriptions, goals, and criteria of the subsystems encompassing air traffic control and is made up principally of the following chapters:

1. En route facilities and services.

2. Terminal facilities and services.

3. Flight service stations.

4. Airspace allocation and rules.

5. Air traffic control research and development.

The basic requirement of the future ATC system is to provide a balanced system capable of being sufficiently expanded to meet the growth in operations and demands for services forecast in the next decade. Included in this basic requirement is the need to improve system availability and reliability to a more satisfactory level of system performance and operation.

It should be noted that since some items (e.g., Mobile Facilities, Radar Video Recording, Voice Recording, etc.) share common usage in both terminal and en route facilities, they are sometimes treated under one or the other chapter as appropriate.

CHAPTER 1. EN ROUTE FACILITIES AND SERVICES

1. En Route Automation.

a. System Requirement. The continuing growth of air traffic will exceed the capacity limits of the current manually managed radar and communications system. To meet the capacity requirements of forecast traffic, the En Route Traffic Control System must be automated eliminating to the extent possible the manual requirements of today's system. When completely implemented, the En Route System will provide 20 automated Air Route Traffic Control Centers covering the conterminous United States and interconnected with data transmission links.

b. System Description. The National Airspace System preliminary design concepts have been developed by the FAA in fulfillment of the objectives of the 1961 Project Beacon Report. Many of these designs and concepts are embodied in the system described here; however, the basic design has been updated progressively to take into account technical advances and changing aviation needs.

In general the Air Traffic Control System provides for the collection of data from multiple sources, automated processing of the data, and display of meaningful data to operating personnel.

The automated Air Traffic Control System is capable of displaying data blocks of flight information adjacent to aircraft positions on FAA controllers' radar scopes. The data blocks, called "alphanumeric tags," contain coded flight information in the form of letters (alpha), numerals (numerics), and symbols. The alphanumeric tags may include aircraft identity, altitude, attitude (whether climbing, descending, or in level flight), and other data needed in air traffic control. These electronic tags once positioned adjacent to the aircraft target will automatically follow it across the radar controller's scope.

In today's system, by comparison, the controller must either memorize the identity of radar aircraft targets or write coded information on clear plastic markers depending on the air traffic control function

he is performing. He moves the markers, called "shrimp boats," manually across the horizontal radar display. Keeping the marker near the moving aircraft target helps the controller remember the correct identity of individual targets. Also, much of the supplementary flight information, such as altitude and time estimates, currently must be handwritten by the controller on paper "flight progress strips." The strips are placed alongside the radar controller's display. Thus, the radar controller's attention is diverted from his display each time he must refer to his flight progress strips. The automated system, on the other hand, puts most of the vital flight data in the alphanumeric tag--on the same radar display that shows the continuously updated progress of the aircraft.

For aircraft equipped with automatic altitude reporting transponders, the alphanumeric tag includes a continuous numerical readout, similar to an automobile's odometer, showing the actual altitude of the aircraft to the nearest 100 feet. In today's system, controllers view only the range and bearing of each plane's position. The third dimension, altitude, must be radioed by voice by the pilot on request of the ground-based controller.

The automated system also performs many other vital functions in the Air Traffic Control System. They include: semi-automatic coordination and transfer of flight control between controllers and between adjacent control facilities; automatic updating of flight data to control sectors; error checking of some pilots' and controllers' actions; automatic processing of flight plans; and electronic display of significant in-flight weather conditions.

Implementation of automation into the En Route System is being accomplished in two steps.

The first step will be the installation of computer equipment to perform flight data processing, using the present manual tracking and display techniques. The flight data processing system will provide automatic flight plan message collection, automatic flight progress strip preparation and distribution within centers and automatic message interchange between adjacent centers. Subsequently, the other major subsystems, digitizers and a computer generated display, will be implemented. These subsystems plus the additional computer capabilities will constitute the full Stage A environment.

c. System Goals. The broad goals of the En Route Automation Program are to continue to enhance safety, increase traffic handling capability, and promote better and faster service to the flying community.

The specific goal of this program is to complete Stage A automation of the 20 continental U. S. centers and provide the following:

Automatic transfer, processing, and updating of flight information.

Automation aids for establishing and maintaining radar identification of aircraft in the system.

Automatic display of altitude or flight level information with aircraft position.

Computer processing capability to serve as the basis for implementation of subsequent automation improvements in air traffic control.

The goal of post-Stage A automation is to identify additional automation features and to implement those that are justified.

d. Criteria for Implementation. Operational experience has demonstrated that en route center traffic volume of about one million IFR aircraft handled per year, results in peaks of activity which overload the manual ATC system. En route traffic projections and forecasts indicate that 15 centers will be above the one million level by 1973 and that all en route centers in the contiguous United States will exceed the maximum manual ATC system capacity level by 1977. Therefore, automation is essential to coping with the increasing workload.

Optimum implementation of the NAS En Route Stage A System is dependent on the following knowledge: the ATC workload in which automation is to be directed; the relationship of workload to specific system designs; the meeting of workload demands for at least 10 to 15 years in the future. Automation in Stage A is generally directed to the processing and displaying of airspace activity data and of related flight plan data. Automation workload is determined from measures and forecasts of this data and from the requirement to perform other routine ATC functions associated with facility operation.

The duration of NAS operation after installation should be on the order of 10 to 15 years as a system design goal, and Central Computer Complex hardware purchased initially is based on the revised 1975 traffic forecasts. Based on the expected long term operation of NAS, additional functional automation can be both defined and implemented after appropriate operational analysis and cost/benefit studies. Hence, computer configuration layouts will be planned to permit growth beyond 1980 anticipated needs.

The needs of each center are estimated and based on:

Computer element requirements.

Data processing load. (display input/output requirements included)

Storage element requirements.

These estimators are based on mathematical models which have been implemented in the form of computer programs to assist in determining future requirements under varying conditions.

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2. Long Range Radar (LRR)

a. System Requirement. The concept of air traffic control employed by the FAA to maintain safe and efficient utilization of the airspace includes the provision of a ground based separation service. This ground based service is either (a) procedural in nature or (b) dynamic, i.e., based on continuous ground derived aircraft position information.

There is a requirement for primary and secondary long range radar in the en route portion of the system to provide the controller with a visual presentation of the traffic in the airspace and to permit reduced separation minima.

There is also a need to improve LRR systems for more adequate coverage and more reliable radar presentations to the air traffic controller. Better weather delineation, target identification, resolution, and other features are required as traffic density increases.

b. System Description. Long range radar (LRR) can generally be described as a system which produces a map-like display for the radar controller of the locations of aircraft within a 200 mile radius of the radar antenna site. The display is presented on a plan position indicator (PPI), at a control sector in the Air Route Traffic Control Center.

The geographical area covered by the radar is displayed on the PPI utilizing electronic video mapping techniques and is placed in such a manner that radar echoes appear at a point corresponding to locations above the earth's surface (map-like).

The LRR also includes secondary surveillance radar as an integral part of the system. Its function is to supplement primary radar

by transmitting beacon interrogating signals to transponder equipped aircraft to trigger a reinforced response which is then shown on the controllers display in a discrete fashion. This beacon reinforced target facilitates aircraft identification and other selective features to facilitate radar identification.

c. <u>System Goal</u>. One goal is to provide full primary and secondary radar coverage of the conterminous United States where criteria are met. Another goal is to integrate available technological progress and state-of-the-art improvements into the system to provide the highest capability for safety and efficiency.

d. <u>Criteria For Implementation</u>. A ground based separation control service utilizing radar permits more efficient utilization of the airspace than a procedural ground based service. It is recognized that some gaps in low activity areas may exist. However, since the ground based system using LRR is considerably more costly, the agency will plan the establishment of LRR only where conditions of mission and high aircraft activity warrant as follows:

Provide radar coverage of airway and route segments with 60 or more IFR peak-day flights. This capability will permit the establishment of positive control airways where appropriate. The specific altitudes at which radar coverage is required will vary with the horizontal distribution of traffic on the airways or routes involved and may, in some instances, be as low as the minimum en route altitude.

Provide continuous radar coverage to insure radar handoff capability between en route and terminal radar facilities with 50,000 or more annual instrument operations.

Provide radar coverage where area positive control is implemented.

Provide radar coverage, in areas of significant air traffic density, at 6,000 feet mean sea level (MSL) and above in non mountainous terrain and at 8,000 feet MSL or minimum en route altitude, whichever is higher, in mountainous terrain.

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3. Air Route Traffic Control Center Structures.

a. System Requirement. As traffic increases and new systems and methods of air traffic control are developed and approved for implementation, a requirement exists to modify the center structures to accommodate these changes. Modifications or expansions of a major nature are planned to meet not only the immediate need, but are planned for a five to ten year life span to preclude repetitive time consuming and interruptive changes.

b. System Description. En route traffic control is conducted from buildings which house the air traffic controller, his electronic gear which include radar and other data displays and communication equipment. The buildings also house maintenance and other personnel functions and elements for the data processing and communication equipment needed to operate and maintain the en route traffic control system. These center buildings are being expanded to accommodate additional sectors required to meet the increased traffic growth and computer space for NAS Stage A automation through the planning period.

c. System Goal. The goal is to expand center structures to accommodate NAS Stage A automation equipment and new sectors made necessary by traffic increases. Building expansions will provide administrative and operational space for the immediate requirement as well as space requirements forecasted for the next decade.

d. Criteria For Implementation. The criterion to modify and expand center buildings follows from the current and projected increases in traffic growth and the decision to provide NAS Stage A automation. The specific design requirements of the buildings are furnished by engineering officers responsible for new or expanded equipments; by the ATC and maintenance planning officers for operating needs in terms of personnel, space and ATC sectors; and by engineering officers responsible for developing facility support plans.

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4. ARTC Center Sectors.

a. System Requirement. A requirement exists to increase air route traffic control sector capacities in order to meet the projected growth in traffic. Sectors along with associated displays must be added, or at a minimum reconfigured to meet the projected increases in aircraft movements over the next ten years.

In addition, voice recording of all communications channels used to provide air traffic control services is required. This simplifies the recording of pertinent information and serves to protect the public interest.

Sectorization and communication recording are proposed to keep pace with the demand for increased air traffic control services.

b. System Description. Air route traffic control centers are subdivided into smaller units called sectors. These sectors are divided by geographic location or by altitude stratification. Such a division more equitably distributes workload and improves operational efficiency. These sectors have discrete communications capabilities and in most cases have radar displays for the area over which they exercise their jurisdiction. As traffic volume increases, it frequently exceeds the capacity of a particular sector and further subdivision and additions or rearrangements of equipment become necessary in order to maintain this operational efficiency.

The voice recording of additional communications channels enables a recreation of events as they have transpired complete with a written (flight progress strips) and aural documentation. This provides a record which supports training activities, can be used as testimony in cases of litigation, and is useful in analyzing certain improvements in air traffic control.

c. System Goal. It is planned to provide enough sectors to satisfy the needs of all aircraft requiring an air traffic control service. As requests grow for these services this capability must be increased ahead of the actual demand in order to assure the necessary level of system safety and capacity.

d. Criteria For Implementation. Sector and Display Additions or Rearrangements. Each manual or radar sector should have a minimum of 61 aircraft operations for the watch. Based on a case by case evaluation a sector area may be divided and a new sector established when the volume of activity for a watch exceeds the following total:

(1) Manual sector - 120 aircraft operations

(2) Radar sector - 180 aircraft operations

Voice Recording. All pertinent data transmitted or received via radio or telephone systems for all positions of operation in the ARTCC should be recorded as shown below. The following priority order will be used on an interim basis when sufficient recorders are not available.

(1) Radar Controller

(2) Sector Controller

(3) Radio Controller

(4) Radar Handoff Controller

(5) AMIS Controller

(6) Coordinator

(7) Assistant Controller

(8) Mission Controller

(9) Flight Data

(10) Watch Supervisor

(11) Flow Control

(12) Data System Coordinator

The lack of recording capability results in some pertinent data transmitted or received via radio or telephone systems to be manually recorded by the controller. We discourage this type of operation insofar as possible since it increases the controller workload.

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5. Mobile Facilities.

a. System Requirement. A requirement exists that the FAA maintain an adequate number of mobile ATC, navigation, and communication facilities. These mobile units are to be used: (1) to meet emergency or special event requirements; (2) to replace facilities destroyed by natural or man-made disaster; (3) to support scheduled maintenance and modernization programs; and (4) to establish temporary service at locations qualifying for facilities where lack of a facility would adversely affect flight safety.

b. System Description. A description of each of the specific elements of the mobile facilities system is as follows:

-- Mobile Air Traffic Control Towers - a mobile facility used for the provision of air traffic control service at an airport.

-- Mobile TVOR - a mobile facility used for the provision of terminal navigational aid services.

-- Mobile AN/FPS-8 radar/beacon - a mobile facility used for the provision of medium range radar service.

-- Mobile COMLO - a mobile facility used for the provision navigational aid services. This facility is generally used as a middle or outer compass locator marker.

-- Mobile VHF/UHF air ground COMVAN - a mobile facility used for the provision of VHF and UHF air ground communications.

-- Mobile engine generators - a mobile facility used for the provision of electrical power.

-- Mobile common digitizer - a mobile facility used for the provision of digitized data transmission.

-- Mobile Instrument Landing System - a mobile facility used for the provision of precision instrument approach information.

-- Mobile Airport Surveillance Radar/Beacon - a mobile facility used for the provision of terminal radar service.

c. System Goal. The goal of the Mobile Facilities System is to have enough units to allow the agency to respond to requirements for temporary air traffic control, navigational aid and air ground communications service to the users of the National Airspace System. Present mobile equipment should be reconfigured to an approved standardized design to permit easy interchange between regions of FAA.

d. Criteria For Implementation. The Mobile Facility Working Committee determines mobile equipment required to satisfy program requirements. This determination is based on historical data and judgmental evaluation of various regional requirements.

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6. Miscellaneous En Route Equipment Improvements.

a. System Requirement

(1) Radar Video Recording.

The Federal Aviation Administration has long recognized the need for recording air traffic control data in order to provide a reconstruction of the traffic conditions existing at the time of an accident, incident or a near miss report.

Communications recording has been satisfactorily achieved and is an invaluable tool. However, due to the volume and complexities of today's air traffic system, communications recordings are not adequate by themselves to totally reconstruct air traffic conditions when required.

Equipment has recently become available which makes radar recording practical. As an added benefit, radar recording will provide the means for analyzing air traffic. This will assist in the development of improvements in the air traffic control/navigation system to expedite traffic, minimize delays, and improve the safe and orderly flow of traffic.

(2) Long Range Radar & Beacon Monitors.

Monitoring of primary long range radar and secondary radar (beacon) are essential elements of providing a safe, efficient air traffic control system. Improved monitoring is needed because continuation of present manual monitoring can allow derogation of the radar and beacon systems due to failure to detect all performance deterioration.

b. System Description.

(1) Radar Video Recording.

This item provides for equipment which will record radar information as displayed to the controller at the radar display position. The recording is made on magnetic tape and is available for replay to give a visual presentation of a traffic situation as it appeared to the controller at any given instant. These tapes, together with the flight progress strips and aural recordings are adequate to provide a complete reconstruction of a given traffic situation and its handling. They may be used for investigation of accidents or questionable incidents or to assist in performing a training function.

(2) LRR and Beacon Monitors.

The LRR and Beacon monitors will measure the performance parameters of long range radar and beacon systems to detect early signs of system deterioration. This early analytic detection will enable maintenance personnel to perform equipment remedial actions before deterioration reaches a level where it must be removed from service or at least prevent lengthy equipment shutdowns.

c. System Goal. The goal is to provide radar video recording on all radar inputs to each ARTCC. At terminal locations the goal is to install video recording at high activity locations where criteria are met. The long range radar and beacon monitors would be provided for all LRR sites.

d. Criteria For Implementation.

(1) Radar Video Recording. Install radar video recorders for terminal and en route radars which serve all large and medium air traffic hubs in the conterminous United States and Honolulu. If no longer required because of NAS Stage A, ARTCC units will be placed at smaller air traffic hub terminal radars.

(2) LRR and Beacon Monitors. All FAA long range radar and beacon systems will be equipped for effective utilization provided the systems they serve are clearly justified by continued and essential use.

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7. Collision Avoidance Systems.

a. System Requirement. Due to the ever-increasing performance and density of air traffic, the probability of near mid-air collisions, both civil and military, is continually rising. Along with this rising trend is the growing number of passengers in any one

aircraft -- particularly in the air carrier classification. Although the Air Traffic Control system (which, along with see-and-avoid, is the primary means of separation) is constantly being improved, it has been recognized by all segments of aviation that a back-up or supplementary subsystem is needed in order to reduce the probability of mid-air collisions.

b. System Description. This Collision Avoidance System (CAS) is cooperative in nature (i.e. protection only exists between properly equipped aircraft and uses a time-ordered technique that has come to be known as time-frequency or t/f). Although not essential in all cases, it is highly desirable that participating aircraft be properly synchronized. This function is primarily accomplished via an aircraft to ground station communication link. As a result of exchanging data and processing it properly, the CAS will (1) detect all aircraft which represent a potential danger , (2) evaluate the degree of hazard, and (3) when an evasive maneuver is necessary the CAS will indicate when and what maneuver should be executed.

c. System Goal. The goal of this program is to develop a system that will minimize the probability of a mid-air collision and to install the needed ground stations at all locations that qualify according to criteria.

d. Criteria for Implementation. Detailed criteria for implementation have not been finalized. From an airborne point of view it is obvious that the greater the number of equipped aircraft the greater the amount of protection that will be afforded. With regard to the ground part of the system FAA is presently analyzing the number and priority of sites in order to provide an optimum ground to air synchronization capability. In the event that additional investigation shows that the time ordered concept should be extended to additional aeronautical functions then it can be expected that this will modify the ground station implementation criteria that would pertain to solely the CAS function. It is estimated that the airspace serving medium or larger hub communities should qualify for CAS coverage before the end of the planning period. However, the specific criterion will be developed on the basis of a benefit/cost analysis conducted prior to field implementation.

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CHAPTER 2. TERMINAL FACILITIES AND SERVICES

SECTION A. MAJOR TERMINAL SYSTEMS

1. Airport Traffic Control Tower (ATCT).

   a. System Requirement. In carrying out its mission of air traffic control, the FAA constructs and operates air traffic control towers for the safe and expeditious operation of aircraft in terminal environment. The FAA must also modernize or reconstruct existing towers that have become inefficient or do not meet operational needs.

   b. System Description. The function of an ATCT is the control of air traffic on or near an airport by direct or indirect vision. An ATCT consists of a control cab, a variable height tower shaft, and an expandable base building. Visibility of the field from the control cab must be as precise and unimpeded as possible. The control cab houses the controller and his equipment with the rest of the structure housing the bulk of the controller's electronic gear.

   c. System Goal. The goal of the agency is the provision of FAA airport traffic control service at all public owned airports meeting the agency tower establishment criteria. The FAA will also modernize or relocate those towers not currently meeting the minimum standards for efficient operation.

   d. Criteria for Implementation. Criteria for implementation of ATCT's involve establishment of new facilities, relocation of existing facilities and modernization of existing facilities. These criteria are discussed under the appropriate subheadings below.

   Establishment.[1/] Under current criteria a publicly owned airport with 24,000 or more annual itinerant aircraft operations is a candidate for an FAA airport traffic control tower (Airway Planning Standard Number One). Proposed criteria revise these standards to a publicly owned "air carrier" airport with 24,000 or more annual itinerant aircraft operations and/or a "general aviation" airport with 50,000 or more annual itinerant aircraft operations. The plan is based on use of these revised criteria.

1/ Establishment criteria do not pertain to Combined Station Towers (CS/T's) as no additions are planned.

Relocation. To meet airport traffic control requirements, ATCTs must be relocated as they become critically obsolescent through physical deterioration of tower structure, inadequate operating and equipment space and changes in airport configuration.

Improve/Modernize. Existing FAA air traffic control towers frequently require improvements and/or additional facilities. Such improvements are usually made only when there exists a reasonable relationship between the operational benefits to be realized and the cost involved in accordance with the following provisions:

-An FAA air traffic control tower recording 35,000 or more annual itinerant operations qualifies for those improvements and/or new facilities that satisfy an operational requirement and/or facilitate the provision of air traffic control service. An activity level of 35,000 or more annual itinerant operations normally assures a cost per itinerant operation that is commensurate with the benefit derived from the improvement or additional facility.

-An FAA air traffic control tower recording 24,000 to 34,999 annual itinerant operations is a candidate for improvements and/or additional facilities. It qualifies for those improvements or additions that satisfy an operational requirement or facilitate the provision of air traffic control service provided that the additional cost does not result in a cost per itinerant operation that exceeds the benefit derived from the improvement or additional facility.

-An FAA air traffic control tower recording less than 24,000 annual itinerant operations is not a candidate for improvements or additional facilities. At that activity level, the additional cost per itinerant operation resulting from the improvement or additional facility is not commensurate with the benefit derived. Any improvement to towers in this category will be limited to the correction of a critical situation and shall be justified by an individual staff study.

e. Bibliography.

(1) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE - TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, Handbook 7031.2, Washington, D.C., May 11, 1965.

(2) U.S. Congress, THE FEDERAL AVIATION ACT OF 1958, Public Law 85-726, Washington, D.C., August 23, 1958 as amended (49 U.S.C. 1301-1541).

(3) Federal Aviation Agency, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Agency Order 1000.1, Washington, D.C., May 6, 1965.

2. Airport Surveillance Radar (ASR) and Beacon System.

a. System Requirement. The concept of air traffic control employed by the FAA to maintain safe and efficient utilization of the airspace includes the provision of a ground based separation service. This ground based service is either (a) procedural in nature or (b) dynamic, i.e., based on continuous ground derived aircraft position information.

-There is a requirement for ASR to provide the controller with a visual presentation of traffic operating in the general vicinity of an airport and to permit application of reduced separation minima as necessary to expedite the safe flow of terminal area traffic.

-There is also a need to improve radar presentations to the air traffic controller. Better weather presentation, target identification, resolution, and other features are required as traffic density increases.

b. System Description. ASR is a radar system specifically designed for air traffic control of aircraft operating within a 60-mile radius of an airport. Aircraft range and azimuth information detected by the ASR is presented on plan position indicators (PPIs) located at a terminal radar approach control (TRACON) room and/or in a control tower cab.

An electronic video map of the area covered by the ASR is displayed on the PPI in such a manner that radar signals received are correlated to locations above the earth's surface.

The ASR also includes secondary surveillance radar (radar beacon) as an an integral part of the system. Its function is to supplement ASR by transmitting and interrogating signals to transponder-equipped aircraft to facilitate radar identification.

c. System Goal. One goal is to provide full primary and secondary radar coverage at airports in the conterminous United States meeting criteria. Another goal is to integrate into the system the available technological progress and state-of-the-art improvements to provide the highest capability of safety and efficiency.

d. Criteria for Implementation. Dynamic ground based separation control service permits more efficient utilization of the airspace than a procedural ground based service. However, since the dynamic ground based system using ASR is considerably more costly, the agency will plan the establishment of ASR only where conditions of mission and high aircraft activity warrant as follows:

Proposed Establishment - Establish ASR at FAA terminal facilities with 50,000 or more annual itinerant operations and 10,000 or more annual air carrier operations.

Current Establishment - An FAA approach control tower recording a total of 20,000 or more annual instrument operations and 100,000 or more annual itinerant operations at all airports under its jurisdiction, except at those airports too distant for the use of radar, is a candidate for airport surveillance radar (ASR) and an air traffic control radar beacon system (ATCRBS)

Improved/Modernized Establishment - Existing FAA approach control towers equipped with ASR/ATCRBS frequently require improvements and additional facilities. Such improvements are usually made only when there exists a reasonable relationship between the operational benefits to be realized and the costs involved, in accordance with the following provisions:

(1). An FAA radar tower facility or FAA staffed RAPCON/RATCC recording 30,000 or more annual instrument operations qualifies for those improvements and/or new facilities that satisfy an operational requirement and/or facilitate the provision of terminal area radar service. An activity level of 30,000 or more annual instrument operations normally assures a cost per instrument operation that is commensurate with the benefit derived from the improvement and/or additional facility.

(2). An FAA radar tower facility or FAA staffed RAPCON/RATCC recording 20,000 to 29,999 annual instrument operations is a candidate for improvements and/or additional facilities. It qualifies for those improvements and/or facilities that satisfy an operational

requirement or facilitate the provision of terminal area radar service provided that the additional cost does not result in a cost per instrument operation that exceeds the benefit derived from the improvement and/or additional facility.

(3). An ASR in an FAA radar tower facility recording less than 20,000 annual instrument operations is not a candidate for improvements or additional facilities. At that activity level, the additional cost per instrument operation resulting from the improvement or additional facility is not commensurate with the benefit derived. Any improvements to terminal radar service at airports in this category will be limited to the correction of a critical situation and shall be justified by an individual staff study. Improvements to FAA staffed RAPCON/RATCCs in this category will be considered on an individual basis but the above guidelines for FAA radar towers shall remain a strong determinant in consideration for qualification.

e. Bibliography.

(1). Department of Transportation, REMARKS PREPARED FOR ALAN S. BOYD, SECRETARY OF TRANSPORTATION BEFORE THE SENATE COMMERCE COMMITTEE, AVIATION SUBCOMMITTEE, Office of the Secretary, Washington, D.C., June 18, 1968, 27 pp. + exhibits.

(2). Federal Aviation Agency, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Agency Order 1000.1, Washington, D.C., May 6, 1965.

(3). Federal Aviation Administration, TERMINAL LOCATIONS FOR PLANNING PURPOSES - CY-1966, Agency Order 1800.5, Washington, D.C., 1967, 45 pp.

(4). Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE-TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, Agency Order 7031.2, Washington, D.C., May 11, 1965.

3. Terminal Automation.

a. System Requirement. A requirement exists in the immediate future to add substantial capacity to the terminal radar system in order to satisfy the forecast traffic growth. This can be done through automation which will open up new alternatives in communications efficiency and air traffic procedures.

The terminal automation program must also be flexible enough to provide for additional modular expansion of capacity and functions so as to enable the efficient and expeditious exploitation of R&D advances in system design.

b. System Description.

ARTS II will automatically display a numeric readout associated with the radar return of transponder equipped aircraft. The numeric display consists of the beacon code or the aircraft control symbol. For aircraft equipped with altitude reporting transponders the altitude is also displayed.

ARTS-III represents the beacon tracking level of the terminal modular automation program. This system will present on the controller's display alphanumeric tags associated with the beacon radar target return. The alphanumeric display consists of the aircraft identification, calculated ground speed, transponder reported altitude, and a control symbol. Special features such as handoff indicators and tabular list data are also part of the basic ARTS-III system. These installations which are readily expandable in both equipment and programming are expected to satisfy functional requirements for at least a 10-year period.

ARTS Improvements - ARTS-II improvements being considered at this time are the addition of alphanumeric identity for 4096 beacon coded aircraft and a limited data exchange with the adjoining en route computer facility.

ARTS-III improvements which are being considered are primary radar tracking, multiple radar processing, digital display techniques, and increased automation assistance such as flow control, sequencing and final approach spacing. The flexibility of this system will permit the addition of new and evolutionary ideas which will result from the widespread field usage of automation equipments.

c. System Goals. The goals of the automation program are:

-To provide every radar terminal with a degree of automation commensurate with the traffic operating in the terminal airspace as specified in accordance with established criteria.

-To implement justified improvements that augment systems capacity and efficiency.

d. Criteria for Implementation.

ARTS-II. All radar control facilities serving small hub airports will receive, as a minimum, a system capable of providing actual (corrected) altitude information from properly equipped beacon aircraft on the controller's display.

ARTS-III. All radar control facilities, serving medium and large hub airports, shall receive a modular programmable automation system. As a minimum, the system will include the capability for displaying alphanumeric identification and calculated ground speeds on all beacon aircraft, plus actual (corrected) altitude readouts from aircraft properly equipped with Mode C transponders. It must minimize controller workload associated with data entries by providing at least automatic flight data exchange with its companion air traffic control facilities.

ARTS Improvements. Add-ons to the ARTS-III systems which will contribute to increased effectiveness include radar tracking, digital radar displays, and final approach sequencing and spacing. Specific criteria do not exist at this time but will be developed from operational analysis and cost/benefit studies.

e. Bibliography.

(1) Federal Aviation Agency, PROJECT BEACON - A STUDY OF THE SAFE AND EFFICIENT UTILIZATION OF AIRSPACE, Report of the Task Force on Air Traffic Control to the President of the United States, Washington, D.C., October, 1961.

(2) Federal Aviation Agency, PROVIDE FOR THE PRESENTATION OF ALPHANUMERICS ON TERMINAL ATC DISPLAYS, Register of Requirements FAAR 6410.3, Washington, D.C., December 29, 196[illegible].

(3) Federal Aviation Administration, DEFINITION OF THE TERMINAL AUTOMATION PROGRAM, Agency Order 6000.10, Washington, D.C., April 8, 1968.

(4) Federal Aviation Agency, COST EFFECTIVENESS ANALYSIS OF THE AUTOMATION OF AIR TRAFFIC CONTROL FUNCTIONS AT RADAR TERMINALS, Washington, D.C., March, 1967.

(5) Federal Aviation Administration, TECHNICAL DESCRIPTION AND SPECIFICATION FOR A MODULARLY EXPANDABLE ARTS-III BEACON TRACKING LEVEL SYSTEM, Washington, D.C., December 15, 1967.

(6) Federal Aviation Administration, AUTOMATED RADAR TERMINAL SYSTEM (ARTS III) SYSTEM DESCRIPTION, Washington, D.C., December 18, 1967.

(7) Federal Aviation Agency, FAA/DOD PROJECT - DIRECT ALTITUDE/ IDENTITY READOUT (DAIR) EQUIPMENT, (Specifications, CP-07877499LID, DOD-AIMS-65-620 Interrogator Set AN/TPX-42 FOR AIMS-SPO 499L), Washington, D.C., Decmeber 18, 1965.

(8) Federal Aviation Agency, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Order 1000.1, Washington, D.C., May 6, 1965.

SECTION B. MISCELLANEOUS TERMINAL IMPROVEMENTS

1. Improved Radar Displays.

a. System Requirement. Wide variances in aircraft flight characteristics coupled with increased radar services dictate an update to modern 16- or 22-inch solid-state indicator display systems.

Modern jet aircraft introduced into the air traffic control system since 1956 operate at speeds and altitudes greater than those for which existing equipments were designed. Furthermore, terminal approach control areas have been expanded from 15 to more than 40 miles and traffic density and control procedures have changed considerably.

b. System Description. ASR-2, ASR-3 and CPN-18 display systems, installed between 1952-1956 are still in use at many FAA operated facilities.

Displays which have either a 10- or 12-inch cathode ray tube (CRT) are considered marginal for control of high speed traffic in today's system. Condensing a 40-mile area into a 10-inch display indicator (approximately nine-inch usable viewing area) presents control problems. For example, three miles minimum radar separation between targets is equivalent to approximately three-eights of an inch.

Modern solid-state ASR display systems provide increased reliability and improve controller performance. The plan position indicators (PPIs) are equipped with 22-inch cathode ray tube displays which are compatible with present plans for displaying alphanumeric data on aircraft identity and direct altitude readout.

c. System Goals. The goals of this program are:

-To replace all obsolete ASR plan position indicators (PPIs) with modern display systems which are compatible with future automation programs for displaying aircraft identity and direct altitude readout.

-To provide the controller with the fastest improvements developed for radar displays.

d. Criteria for Implementation. All obsolete ASR plan position indicators (PPIs) are eligible for replacement with modern display systems.

e. Bibliography

(1) Department of Transportation, REMARKS PREPARED FOR ALAN S. BOYD, SECRETARY OF TRANSPORTATION, BEFORE THE SENATE COMMERCE COMMITTEE AVIATION SUBCOMMITTEE, Washington, D.C., June 18, 1968.

(2) Federal Aviation Agency, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Order 1000.1, Washington, D.C., May 6, 1965.

(3) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE-TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, Handbook 703[illegible].2, Air Traffic Service, Washington, D.C., May 1[illegible], 1965.

2. Expanded Radar Service (Stage II).

a. System Requirement. The intermixing of VFR and IFR arrival traffic in high activity terminal areas has always been a serious problem for the airport controller. There is a need to improve traffic flow in the terminal area and to aid pilots to see and avoid other traffic by providing radar traffic information on possible conflicting traffic.

b. System Description. Expanded radar service consists of issuing traffic advisories to arriving and departing flights within the terminal area and sequencing, on a full-time basis, the VFR aircraft landing at the primary airport. Participation by pilots of VFR aircraft is on a voluntary basis.

This service is provided through the use of Airport Surveillance Radar (ASR) which were installed at major airports primarily for the control of IFR traffic. Based on several years of operational experience, it has been concluded that this equipment can also be used effectively in providing greater service to VFR aircraft, thereby improving the efficiency and safety of operations in the terminal area.

c. System Goal. The goal of this program is to provide expanded radar service to enhance airport safety and efficiency at all locations justified by individual site analysis.

d. Criteria for Implementation. Although criteria for implementation is not firm, there would be little, if any need for Stage II in a radar terminal having less than 150,000 total aircraft operations. This limit should be regarded as general guidance in the selection of "staff study" candidates only and progression to Stage II is dictated by the airport and terminal airspace environment as well as the volume of traffic.

e. Bibliography

(1) Department of Transportation, REMARKS PREPARED FOR ALAN S. BOYD, SECRETARY OF TRANSPORTATION, BEFORE THE SENATE COMMERCE COMMITTEE, AVIATION SUBCOMMITTEE, Office of the Secretary, Washington, D.C., June 18, 1968, 27 pp. + exhibits.

(2) Federal Aviation Agency, NATIONAL TERMINAL RADAR PROGRAM, Agency Order 7110.23, Washington, D.C., March 25, 1964.

(3) Federal Aviation Administration, AIRMAN'S INFORMATION MANUAL - PART 3 - OPERATIONAL DATA AND NOTICES TO AIRMEN, Washington, D.C., issued every 28 days.

3. Airport Surface Guidance Equipment

a. System Requirement. A requirement exists to improve the airport surface guidance and control system for handling the increasing complexity and volume of aircraft operating at high activity airports.

b. System Description.

Present System consists of a conventional radar display system which gives the controller a pictorial presentation of aircraft on the airport surface. The system will be modified to increased effectiveness by the addition of bright displays.

Follow-on System will use induction loops installed in the runway/taxiway/ramp surfaces. Detection information is fed to a display and control panel. The pilot is provided guidance and control information by selectively controlled taxiway centerline lights and stop bars.

c. System Goal. Provide for the modernization and continued use of airport surface detection equipment (ASDE) where currently installed until a replacement system for performing the ground detection and display functions is available. At the same time, allow for the evolutionary introduction of system improvements through the installation of components and elements of a complete system for guidance and control at those locations justified by implementation criteria.

d. Criteria for Implementation. Presently, there are no established criteria for ASDE. The criteria development will be based on traffic quantity, weather category of operation, aircraft type category of operation, and airport environment (tower perspective, obstructions to vision). The highest priority airports for the full system will be the eventual Category III airports.

e. Bibliography.

(1) Federal Aviation Agency, DEVELOP ALL-WEATHER AIRPORT SURFACE GUIDANCE AND CONTROL SUBSYSTEM, Register of Requirements FAAR 5355.1, Washington, D.C., September 13, 1966.

(2) Federal Aviation Agency, AIRPORT SURFACE DETECTION EQUIPMENT (ASDE), Order 6330.1, Washington, D.C., February 15, 1966.

(3) Radio Technical Commission for Aeronautics, AN AIRPORT SURFACE TRAFFIC CONTROL SYSTEM (STRACS), Paper presented by L. Achitoff at RTCA Meeting, Washington, D.C., September 26, 1968.

4. Terminal Electrical Systems

a. System Requirement. The agency requires that electrical power systems for terminal facilities be of sufficient quality to ensure the safe and efficient movement of air traffic. FAA policy requires that all key terminal facilities have either "on-site" engine generators or a second source of commercial power to provide a backup capability in the event of prime power failure. After the 1965 massive commercial power failure in northeastern United States demonstrated the possiblity of a simultaneous loss of two and three sources of commercial power, the agency designated certain airports as Continuous Power Airports (CPAs) requiring continuous power facilities to ensure the existence of a power system independent of commercial power sources in the event of a widespread commercial power failure.

b. System Description. Electrical power systems for terminals must be of sufficient quality to ensure the safe and efficient movement of air traffic.

All key terminal facilities must have either "on-site" engine generators or a second source of commercial power to provide a backup capability in event of prime power failure.

In addition, 50 high density airports have been designated as Continuous Power Airports (CPAs) requiring continuous power facilities to ensure the existence of an independent power system in the event of a widespread commercial power failure.

c. System Goal. The goal of the agency is to provide terminal electrical power systems of sufficient quality and reliability to ensure the safe and efficient movement of air traffic. Also, to ensure that a basic air traffic control system and its support facilities remains in operational status at certain high density airports in event of an area-wide or catastrophic commercial power failure.

d. Criteria for Implementation. The minimum quality and reliability of electrical power needed at a terminal varies with the effect that an outage of the specific facility or system would have on air safety and air traffic control effectiveness. The exact relationship of an individual facility to its operational environment, of course, is unique but each type of facility (e.g., Instrument Landing System, ILS; and Airport Surveillance Radar, ASR) has been evaluated and provided a specific power configuration classification. This power classification denotes the electrical power requirements for a particular facility as well as its essentiality to the National Airspace System.

e. Bibliography

(1) Federal Aviation Agency, PROVISION OF ELECTRICAL POWER FOR NATIONAL AIRSPACE SYSTEM FACILITIES, Agency Order 6030.20, Washington, D.C., March 6, 1967.

(2) Federal Aviation Administration, POWER POLICY IMPLEMENTATION AT NATIONAL AIRSPACE SYSTEM FACILITIES, Agency Order 6950.2, Washington, D.C., December 29, 1967.

(3) Federal Aviation Administration, MECHANICAL ELECTRICAL SYSTEMS DISRUPTION HANDBOOK, MEDIUM LEVEL, AIRPORT TRAFFIC CONTROL TOWER, Handbook 6930.11, Washington, D.C., May 17, 1968.

(4) Federal Aviation Administration, POWER POLICY CONFIGURATION WAIVER, Notice 6950.9, Washington, D.C., February 1, 1968.

5. Improve Beacon Systems

a. System Requirement. The introduction of terminal automation programs into the system requires that early model interrogators be modified or replaced to provide additional capacity for reporting aircraft altitude and identity. In addition, old type defruiters must be replaced to permit display of both data. Improved side lobe suppression is needed to reduce false targets. Future development of a narrow beacon antenna must be accomplished to reduce target sizes and improve acquisition and display of beacon data.

b. System Description. The ATCRBS is a cooperative secondary radar system designed to provide reliable identity, altitude and position data for use in the ATC system. The FAA must provide the ground portion of the system which includes the interrogator and the means to display identity, altitude and position data on the ATC display. The airborne transponder which replies to the interrogator is the responsibility of the aircraft operator to provide and maintain.

The 4096 code ATCRBS, Mode 3A (identification) and Mode C (altitude), is a major building block in the terminal automation system. Automatic acquisition, tracking and identification is based upon a discrete Mode 3A. The Mode C altitude data is automatically coded and transmitted to the ground when interrogations are received in the aircraft. Additional processing by the terminal automation system will transform these data into alpha-numeric form on the ATC display.

c. System Goal. Improve all present ASR beacon systems. These and all new (future) systems will have the capability to satisfy the terminal automation requirements. As new ASR facilities are phased into the system, these improvements, when available, will be made a part of the total ASR package.

d. Criteria for Implementation. All terminal beacon systems qualify for demonstrated improvements that add to the integrity and effectiveness of the system.

e. Bibliography.

(1) Federal Aviation Agency, PROVIDE IMPROVED TERMINAL RADAR AND BEACON C, Register of Requirements FAAR 6310.2, Washington, D. C., October 14, 1966.

(2) Federal Aviation Administration, PROVIDE IMPROVED ATCRBS INTERROGATORS FOR JOINT-USE RAPCON/RATCC FACILITIES, Register of Requirements FAAR 6360.2, Federal Aviation Administration, Washington, D. C., July 6, 1967.

(3) Federal Aviation Agency, PROVIDE FOR THE PRESENTATION OF ALPHANUMERICS ON TERMINAL ATC DISPLAYS, Register of Requirements FAAR 6410.3, Federal Aviation Administration, Washington, D. C., December 29, 1966.

6. Provide ASR & Beacon Ground Station Monitors.

a. System Requirement. Continuous electronic monitoring of the ASR and beacon system is required to insure optimum system operation and to provide the operator with assurance that an accurate display of radar data is being provided.

b. System Description. The ASR/beacon monitor provides continuous monitoring of the current status of the radar system with respect to all outputs and signals received for display to the controller. It provides a fault signal when range and azimuth signals shift beyond a tight tolerance, thereby providing an indication that false targets are being displayed. In addition, the beacon monitor maintains a constant listening watch for the transmission of ATCRBS beacon codes of 7700, the emergency code, and 7600, the radio failure code. When these codes are received, an alert device is activated to call the controller's attention to the emergency or radio failure. Implementation of the monitor will enhance the safety of the radar data acquisition systems.

c. System Goal. Install ASR and beacon ground station monitors at all ASR facilities.

d. Criteria for Implementation. All ASR facilities qualify for the installation of ASR and beacon monitor systems. These systems provide a margin of safety that cannot be realized by constant maintenance and operator surveillance of the system.

e. Bibliography.

(1) Federal Aviation Agency, PROVIDE RADAR PERFORMANCE MONITOR, Register of Requirements FAAR 6310.1, Federal Aviation Administration, Washington, D. C., September 7, 1966.

(2) Federal Aviation Agency, PROVIDE IMPROVED MONITORING OF ATCRBS, Register of Requirements FAAR 6360.1, Federal Aviation Administration, Washington, D. C., October 11, 1966.

7. Display Weather Data on Scopes.

a. System Requirement. Severe weather always has an adverse affect on the efficient and expeditious flow of air traffic by reducing the size of available safe airspace, especially in the terminal areas. There is a need, therefore, to display a contour of severe weather directly on the controllers' radar scope with a capability for immediate weather information deletion as required by the controller.

b. System Description. Weather data on controller radar scopes will show potentially hazardous weather conditions in the form of equal weather intensity contours surrounding areas of thunderstorms, live squalls, hail, turbulence, icing conditions, etc.

c. System Goal. Provide weather displays on all radar scopes where justified in accordance with implementation criteria.

d. Criteria for Implementation. Agency criteria are not firmly established. Weather information will be displayed on all radar scopes in terminal and en route facilities where studies of airspace activity and weather incidence justify the installation of the equipment. Installation priority will be based on the airspace value of each proposed installation.

e. Bibliography.

(1) Federal Aviation Agency, COMPUTER PROGRAM FUNCTIONAL SPECIFICATION, WEATHER INPUTS AND OUTPUTS, SPO-MD-125, Washington, D. C., November 1, 1966.

(2) Department of Commerce, FEDERAL PLAN FOR WEATHER RADARS AND REMOTE DISPLAYS, OFCM 67-3, Environmental Science Services Administration, Washington, D. C., May 1967.

8. Digital Weather Displays.

a. System Requirement. Digital weather displays are required to provide the air traffic controller with a compact, standardized, digital weather package, designed to allow improved reading, to eliminate interpretation, and to reduce concentration, thus increasing controller accuracy as well as conserving critical space.

b. System Description. The presentation of wind (direction, velocity and peaks), altimeter setting, runway visibility, runway temperature and time in digital form is in a composite package approximately 9x11 inches. The information for each element displayed is updated each minute. The digit size for each element is a standard size and compatible to other digital displays provided the controller. It is easily readable in both the control tower cab and the darkened environment of the radar room.

c. System Goal. The goal is to provide these displays at all airport traffic control towers and TRACON facilities. These installations will be made in annual increments as determined by criteria.

d. Criteria for Implementation. All airport traffic control towers, TRACONS, RAPCONS and RATCCS operated by the FAA qualify for digital weather displays. Determinations of priority installation rankings will be based on the annual count of itinerant operations, i.e., higher activity radar level facilities will be given preference over locations of lower activity.

e. Bibliography.

(1) Federal Aviation Agency, ALTIMETER SETTING INDICATORS SPECIFICATION - FAA-E-2070, Washington, D. C., January 15, 1964.

(2) Federal Aviation Agency, WIND, SPEED DIGITAL READOUT SYSTEM, FAA-E-2135, Washington, D. C., September 19, 1966.

(3) Federal Aviation Administration, CLOCK, SINGLE LINE, 24-HOUR AUTO-CORRECTED, FAA-E-2317, Washington, D. C., December 26, 1967.

(4) Federal Aviation Administration, REMOTE AIR TEMPERATURE SENSOR, FAA-E-2330, Washington, D. C., July 2, 1968.

(5) Federal Aviation Agency, RUNWAY VISUAL RANGE SIGNAL DATA CONVERTER SYSTEM - FAA-E-2267, Washington, D. C., August 3, 1966.

(6) Federal Aviation Agency, WEATHER DISPLAY PANEL, FAA-E-2274, Washington, D. C., February 2, 1967.

(7) Federal Aviation Admin. FACILITY OPERATIONS, Handbook 7230.1A, Air Traffic Service, Washington, D. C., April 1, 1967.

(8) Federal Aviation Administration, TERMINAL AIR TRAFFIC CONTROL, Handbook 7110.8, Washington, D. C., October 1, 1967.

(9) Federal Aviation Agency, REQUEST FOR RESEARCH AND DEVELOPMENT - COMPOSITE DIGITAL WEATHER PACKAGE, FAA Form 2864, Washington, D. C., April 17, 1962.

9. Automatic Terminal Information Service (ATIS).

a. System Requirement. There is a requirement for an automated pilot briefing system to enhance weather dissemination and relieve controller workload.

b. System Description. ATIS provides recorded wind, altimeter, and runway-in-use information to arriving and departing aircraft. Recorded by the control tower, the information is broadcast continuously on a VOR or a discrete VHF frequency.

c. Goal. The goal of this program is to provide recorded weather briefings at all terminal facilities meeting establishment criteria.

d. Criteria for Implementation. Airway Planning Standard No. 1 provides for the establishment of Automatic Terminal Information Service at all terminal facilities having 100,000 or more annual itinerant operations.

e. Bibliography.

(1) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE - TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, Handbook 7031.2, Washington, D. C., May 11, 1965.

10. Automatic Weather Sensing and Transmission.

a. System Requirement. Detailed and timely terminal weather information to tower controllers, FSS, ARTCC, dispatchers, pilot briefing rooms, etc., is essential to decisions in air traffic control, flight planning, briefing, aircraft loading, etc. A requirement exists to replace the costly procedure of manually taking and reporting weather data at limited airport weather reporting stations.

b. System Description. The automatic weather sensing and transmission system includes equipment for the sensing, transmission, data processing and display of ceiling, runway temperature, dew point, wind speed, wind direction, wind peak, cloud condition and altimeter setting.

Sensing and transmission devices have been developed for all parameters except cloud cover.

c. System Goal. The goal of the agency is to replace the costly practice of assigning FAA or USWB personnel to limited airport weather reporting stations (LAWRS) for obtaining the required weather observations.

d. Criteria for Implementation. The criteria for the installation of the automatic weather sensing and transmission system have not been firmly established. However, pending the satisfactory development of this system, it is expected that it will replace LAWRS. The latter is usually planned at airports, both air carrier and general aviation, which are programmed to install instrument landing systems with approach lights for the first time. This weather system may eventually supplant the manual observations made at the flight service stations.

e. Bibliography.

(1) Federal Aviation Administration, VISUAL RANGE MEASUREMENTS, Register of Requirements FAAR 5335.1, Washington, D. C., October 27, 1967.

(2) Federal Aviation Agency, DEVELOP ALL-WEATHER GUIDANCE CONTROL SUBSYSTEM, Register of Requirements FAAR 5355.1, Washington, D. C., September 13, 1966.

(3) Federal Aviation Administration, INTERIM SITING CRITERIA FOR TEMPERATURE SENSORS, Order 6560.4, Washington, D. C., August 13, 1968.

(4) Federal Aviation Administration, INTERIM SITING CRITERIA FOR AIRPORT WIND SENSOR, Order 6560.3, Washington, D. C., August 13, 1968.

(5) Federal Aviation Administration, SITING AND INSTALLATION OR STANDARD RUNWAY VISUAL RANGE EQUIPMENT FOR CATEGORY I AND II OPERATIONS, FAA-STO-008, Order 6990.3, Washington, D. C., June 29, 1967.

(6) Federal Aviation Administration, ROTATING BEAM CEILOMETER SYSTEM, DOT-FAA Specification FAA 2326, Washington, D. C., June 10, 1968.

(7) Federal Aviation Administration, TEMPERATURE AMBIENT AND DEW POINT SYSTEM, DOT-FAA Specification FAA-E-2342, Washington, D. C., June 14, 1968.

(8) Federal Aviation Administration, A PROGRAM TO PROVIDE APPROACH AND LANDING AIDS AT SCHEDULED AIR CARRIER TURBOJET AIRPORTS, Memorandum Report, Approach and Landing Aids Committee, Washington, D. C., January 1968.

(9) Federal Aviation Administration, FACILITY OPERATION, Handbook 7230.1A, Washington, D. C., April 1, 1967.

CHAPTER 3. FLIGHT SERVICE STATIONS

1. FSS and IFSS

a. System Requirement. Federal statutes place a general responsibility upon the Government to provide aviators with aviation weather information. The Federal Air Regulations require pilots to obtain a preflight weather briefing for other than local flights. By interagency agreement, the FAA is made responsible for the collection of meteorological data and its distribution to aviation users. The FARs require IFR and DVFR flights to file flight plans and IFR flights to obtain an ATC clearance for flights within controlled airspace. The first three system requirements listed below are based upon the abovementioned statutory and regulatory provisions and interagency agreement; the fourth is in response to the general statutory mission of the agency.

(1) There is a requirement for FSSs to collect and distribute meteorological data and aeronautical information to major aviation users, including Weather Bureau offices, ATC facilities, airlines, and other private users.

(2) There is a requirement to disseminate meteorological data and aeronautical information to general aviation pilots (and others as required) before and during flight.

(3) There is a requirement for FSSs to accept IFR/DVFR flight plans and forward them to ARTC centers (and to military bases when required); FSSs must also relay ATC approach and departure clearances to aircraft operating at nontower IFR airports. IFSSs must also relay en route ATC messages and, in some areas, air carrier operational messages.

(4) There is a requirement for FSSs to provide emergency navigational assistance to lost or disoriented aircraft. FSSs also operate a voluntary VFR flight plan system and various special reporting services (lake, ocean, mountain, island, swamp) to ensure speedy search and rescue of overdue aircraft.

To satisfy the foregoing functions, it is necessary to maintain a network of flight service stations of various capabilities, sufficient to meet the demands for service; this includes the modernization, repair and possible realignment of functions at existing stations. A need exists for a systems study to determine the most efficient role of the flight service stations in the NAS.

This should include a re-assessment of the above requirements in view of the on-going en route and terminal automation programs.

b. System Description. The flight service station is an operational facility which performs a variety of functions, most of them relating to the acquisition, distribution, and dissemination of meteorological and other aeronautical information having a bearing on the safety of flight. Each FSS has a flight information area encompassing numerous airports and navaids, and many square miles of air space.

The FSS system originates over 200 weather observations; through interphone, telewriter, and teletypewriter circuits it collects several hundred other surface and synoptic observations and distributes them to processors (meteorological offices) and direct users. Processed data, such as forecasts, are in turn relayed to direct and indirect users. The teletypewriter system also distributes NOTAMs, and relays IFR and VFR flight plans to ARTC centers, military bases, and other flight service stations.

FSSs provide in-person briefings and self-briefing facilities to pilots at the local airport and, through an extensive system of leased telephone lines, telephone briefing to pilots at more than a thousand airports in nearly as many communities. The same system is used to receive flight plans. In heavily populated areas, FSSs also operate mass weather dissemination systems, transmitting transcribed briefings by radio and telephone.

FSSs provide inflight weather briefings, warnings, and advisories through a system of over 800 strategically located radio communications outlets. This communications system is also used to relay approach and departure clearances at nontower airports, to monitor en route navaids, and to provide, often in conjunction with direction-finding equipment, emergency assistance to lost or disoriented aircraft. Stations equipped with weather radar displays can provide inflight weather avoidance service to VFR aircraft.

c. System Goals. Agency goals include: automated high-speed weather data distribution system with request-reply capability; direct entry of IFR flight plans to ARTCC computers (satisfied in part by flight service stations); direction finder network with nation-wide coverage at minimum en route altitudes along major air routes.

d. Criteria for Implementation. Specific criteria have not been approved for FSSs and IFSSs. Establishment, discontinuances, changes in operating

hours, and service expansions are currently considered on a case by case basis. As a result of the current systems study a rationale will be developed for these decisions.

e. Bibliography.

(1) US Congress, THE FEDERAL AVIATION ACT OF 1958, Public Law 85-726, Washington, D. C., August 23, 1958 as amended, (49 U.S.C. 1301-1541)

(2) Federal Aviation Agency, MEMORANDUM OF AGREEMENT BETWEEN THE FEDERAL AVIATION AGENCY (FAA) AND THE ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION (ESSA), For the establishment of working arrangements for providing aviation weather service and meteorological communications, Agency Order 7000.2, Washington, D. C., September 2, 1965, 43pp.

(3) Federal Aviation Agency, FEDERAL AVIATION REGULATION, PART 91, General Operating and Flight Rules and PART 99, Security Control of Air Traffic are amended, Federal Aviation Regulations, Superintendent of Documents, Government Printing Office, Washington, D. C., Part 91, 28pp, Part 99, 9pp.

(3) Federal Aviation Agency, GENERAL OPERATING AND FLIGHT RULES, Federal Air Regulation, Part 91, Washington, D. C. as amended Code of Federal Regulations, Janaury 1, 1968 edition.

(4) Federal Aviation Agency, SECURITY CONTROL OF AIR TRAFFIC, Federal Air Regulations, Part 99, Washington, D. C., as amended Code of Federal Regulations, January 1, 1968 edition.

2. Equipment Support.

a. System Requirement.

(1) DF Equipment and Remoting. There is a requirement for a direction finder network capable of providing emergency navigational assistance to lost aircraft or aircraft in distress. In some cases, bearing indications must be transmitted by long-line from remote sites to avoid excessive gaps in coverage.

(2) Recorders. There is a requirement to record air/ground communications and telephone briefings at flight service stations and international flight service stations. It is more efficient to use voice recorders for this purpose.

(3) Weather Observing Equipment. There is a requirement to improve the accuracy of weather observations and to reduce the time required to take them through the use of rotating-beam ceilometers and direct-reading hygrothermometers.

(4) Weather Radar Displays. Weather radar displays permit FSSs to give pilots in flight more accurate and timely advice on adverse weather than does any other data source. The data obtained from radar displays is also valuable in preflight briefing.

There is a requirement to equip additional FSSs wi h weather radar displays concurrently with Weather Bureau expansion of its weather surveillance radar and slow-scan transmission systems.

(5) Voice/Graphic Communications to Forecaster. There is a requirement for a voice-graphic communications system between forecasters and flight service stations, which are not collocated with a Weather Bureau office. This enables briefers to be kept current on changing weather situations and forecasts. The system ill also serve pilots who require the advice of a professional meteorologist.

(6) Mass Weather Dissemination and Automated Preflight Briefing. Because of our inability to provide individualized briefings to all pilots, th e is a requirement for an improved aural mass dissemination system which will provide pilots with a substantial percentage of the weather information they need, and for an audio-visual mass dissemination system. These requirements and those for an automated preflight briefing system are being reviewed as part of the FSS Systems study.

b. System Description.

(1) DF Equipment and Remoting. Doppler VHF/UHF DF equipment presents the control station with the bearing of any aircraft within range transmitting on any of the frequencies pre-set into the equipment. The only airborne equipment required is a transceiver. DF equipment can be remotely controlled by converting the bearing indication to digitized data and transmitting it over voice-quality telephone lines. The equipment can be used to home an aircraft on the DF site, vector an aircraft to an off-site airport, or provide an emergency instrument approach.

(2) Recorders. FSSs and IFSSs are required to record air/ground communications and information furnished pilots in preflight briefings. Voice recorders are not in current use. The five-

channel, solid-state cartridge-loaded recorders, which have been adopted as the agency standard, can simultaneously record four positions of operation and a time channel. One recorder will meet all the needs of 90 percent of the stations in the system. Each station having a recorder will also need a reproducer.

(3) Weather Observing Equipment. Rotating-beam ceilometers indicate, every six or twelve seconds, the cloud height over the area of the middle marker. The height indication is presented on a recorder or an oscilloscope. This indication, together with a rapid visual observation, results in extremely accurate ceiling and sky cover value. Direct-reading hygrothermometers present a digital readout of temperature and dew point at the weather observer position. They eliminate the need for the FSS specialist to leave the station to read the dry and wet bulb thermometers.

(4) Weather Radar Displays. Several types of displays are available to depict weather surveillance radar data. The PPI repeater scope connected by cable to the WSR-57, or equivalent, radarscope is the most common display now in use at flight service stations, but the least satisfactory. At locations where the Weather Bureau has a slow-scan telephone transmission system in operation the FSS can utilize either a television monitor or a facsimile printer. The TV monitor is by far the most useful presentation for FSS purposes.

(5) Voice/Graphic Communications To Forecaster. This system, which requires two voice-quality telephone lines, operates on the same principle as the telewriter. The meteorologist at a FAWS office can depict weather information on a map while talking to the pilot briefers at a distant FSS. The distant FSS receives the data on an identical map at its end, which can also be projected.

(6) Mass Weather Dissemination. The Transcribed Weather Broadcast (TWEB) is a recorded synopsis of current aviation weather and forecasted outlook broadcast continuously on an L/MF nondirectional beacon or a VOR. Pilot Automatic Telephone Weather Answering Service (PATWAS) enables a pilot to obtain a preflight weather briefing by dialing a special number from home or airport telephone. TWEB and PATWAS generally employ the same script and, in some instances, the same recording is used. There are several variations of PATWAS which enable the caller to select information for a s[illegible]ute or area.

(7) Automated Preflight Briefing Equipment. Automated preflight briefing equipment has not yet been developed to provide pilots

with a computer-derived profile of weather and NOTAMS for his proposed route of flight in hard-copy form. Such equipment may become a part of the system only if cost/benefit studies justify the expenditure.

c. System Goal.

(1) DF Equipment and Remoting. The agency goal is to provide VHF-DF coverage at minimum en route altitudes along heavily-traveled air routes. The extent of the UHF-DF network is contingent upon military requirements which have not yet been formally stated.

(2) Recorders. The agency goal is to record all air/ground communications and telephone briefings at all FSSs and IFSSs.

(3) Weather Observing Equipment. The goal of the agency is to provide direct-reading hygrothermometers and rotating-beam ceilometers at all terminal facilities which take weather observations.

(4) Weather Radar Displays. The goal of the agency is to provide radar display equipment at certain stations where dictated by administrative review. This goal will be refined on the basis of the system study.

(5) Voice/Graphic Communications To Forecaster. The goal will be established on the basis of the system study.

(6) Mass Weather Dissemination. The goal of the agency is to relieve the workload on FSS pilot briefers and terminal controllers. The specific consequences of this goal in terms of mass dissemination will be determined by the current system study.

d. Criteria for Implementation.

(1) DF Equipment and Remoting. The present criteria (contained in Airway Planning Standard Number Two) provide, generally, for the installation of DF equipment at about 150 FSSs. DF sites are required at intervals of 80 to 160 nautical miles along heavily-traveled routes.

(2) Recorders. All flight service stations are eligible for multichannel recorders. The requirement has a lower priority than that of en route and terminal facilities. The proposed criterion for installation priority is the rank order of aircraft contacted plus pilot briefs.

(3) Other Equipment. Specific criteria have not yet been adopted for weather observing equipment and weather radar displays at FSS's, voice-graphic communications to forecasters, and mass dissemination. The plan is based on the following proposed criteria which may be modified as a result of current system studies.

Weather Observing Equipment. Rotating-beam ceilometers and direct-reading hygrothermometers will be installed on an incremental basis. First priority will be terminal facilities which take weather observations, with second priority given to full-time FSSs (which take weather observations) at air carrier airports and other airports which meet the activity criteria for the establishment of a control tower.

Weather Radar Displays. Proposed criteria have been developed and are included in the draft Airway Planning Standard Number Three (APS #3). Criteria must be based on activity plus availability of Weather Bureau or military weather radars as the FAA does not own or operate weather radars. On this basis it is proposed to provide weather radar displays at full-time FSSs which are within 100 nautical miles of an S-band (WSR-57) weather radar or within 50 nautical miles of a C-band weather radar, provided that the FSS provides at least 10,000 annual pilot briefs. Other stations will be provided with displays if their activity exceeds 15,000 annual pilot briefs and there is a weather radar available within the metropolitan area or they are collocated with a Weather Bureau station having a WBTTS-65 receiver.

Voice/Graphic Communications to Forecaster. It is proposed that all full-time stations which are not collocated with a Weather Forecast office, and a few of the busiest part-time briefing stations, be provided with this equipment.

Mass Weather Dissemination. It is proposed to provide PATWAS at all large and medium air traffic hubs. This corresponds closely to the present PATWAS configuration. It is proposed to provide VHF/TWEB at all full-time FSSs. The present L/MF TWEB would not be expanded but would gradually be phased out. The same recording equipment (ATIS equipment) can be used for both PATWAS and TWEB at those stations which provide both services. The scheduled weather broadcast service would be phased out as VHF/TWEB, utilizing VOR voice channels, is phased in.

Automated Preflight Briefing. The program is in the early stages of research and development, and firm operational criteria have not been developed. The plan is based on installation of remote input/output devices at all full-time FSSs during the period of the plan.

(e) Bibliography.

(1) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER TWO - AIR ROUTE TRAFFIC CONTROL, Handbook 7031.3, Washington, D. C., July 2, 1965, 12 pp.

(2) Federal Aviation Administration, REQUIREMENTS FOR MULTI-CHANNEL RECORDERS IN FLIGHT SERVICE STATIONS, Staff Study, Washington, D. C., undated, 10 pp.

(3) National Transportation Safety Board, SAFETY RECOMMENDATIONS, SB 68-29, Washington, D. C., April 3, 1968, 4 pp.

(4) Department of Commerce, FEDERAL PLAN FOR WEATHER RADARS AND REMOTE DISPLAYS, Washington, D. C., May 1967, 53 pp.

(5) Federal Aviation Agency, FLIGHT SERVICE STATION TASK GROUP REPORT, Report - Notice 7233.2, Federal Aviation Administration, Washington, D. C., February 10, 1967, 15 pp.

(6) Federal Aviation Administration/Aviation Industry, REPORT OF INDUSTRY/WORKING GROUP ON FLIGHT SERVICE STATIONS, Washington, D. C., May 15, 1967, 17 pp.

(7) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE - TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, Handbook 7031.2, Washington, D. C., May 11, 1965, 19 pp.

CHAPTER 4. AIRSPACE ALLOCATION AND RULES

1. Positive Control Airspace.

   a. System Requirement. It has become more and more apparent that a pilot's ability to see and avoid other traffic is adversely affected by high aircraft speeds and resultant high closure rates. It is also apparent that there are limits of congestion beyond which random VFR operations cannot be tolerated. As advancing technology produces higher-performance and more sophisticated aircraft, and as the airline and general aviation fleets continue to expand, reliance on the see-and-be-seen type of collision avoidance will become less and less prudent. The greater size and speed of the planes using the airspace, combined with the increased density of traffic, will create a corresponding increase in the number of flights which must be controlled by the ATC system.

   In order to maintain a high level of safety for air travellers, a much larger and more technically sophisticated national airspace system will be needed. Regulation and control must continue to expand, and, in order to eliminate "unknowns" in highly congested airspace, positive control airspace must be lowered -- in some areas down to the surface.

   b. System Description. Positive control provides the best available means of assuring separation between aircraft. Positive control airspace can be defined as airspace in which reliance on the "see and avoid" concept of aircraft separation is virtually eliminated. In a positive control environment, separation between all aircraft is provided by the air traffic control system through issuance of clearances and instructions. While it is still incumbent on the pilot, when possible, to avoid any risk of collision that he may see, the occasions when the "see and avoid" concept of separation would be applicable are minimized. The agency considers the risk of midair collision to be less in a positive control environment than anywhere else in the system.

   c. System Goal. Positive control airspace must be established wherever the agency has the capability to provide the service and where the volume and type of traffic indicate that it is in the public interest to provide it.

d. Criteria for Implementation. Establishment criteria for positive control airspace, consider factors of air traffic density and closure speeds, among others. Each step in the lowering of APC will require rule making action and each of these rule making actions will require the publication of a notice of proposed rule making affording all interested parties the opportunity to submit their views.

e. Bibliography.

(1) Federal Aviation Agency, AIRBORNE RADIO NAVIGATION AND COMMUNICATIONS EQUIPMENT FOR GENERAL AVIATION AIRCRAFT, AND RELATED CONSIDERATIONS, 1965-75, Advance Notice of Proposed Rule Making (Docket No. 6606; Notice 65-9) April 23, 1965, 3pp.

(2) Federal Aviation Administration, POSITIVE CONTROL AREA, Notice of Proposed Rule Making (Airspace Docket No. 67-WA-16) May 11, 1967, 2pp.

(3) Federal Aviation Administration, ORIENTATION OF A GOVERNMENT REGULATORY AND ENFORCEMENT AGENCY FOR THE DECADE 1970-80, Paper prepared by D. D. Thomas, Deputy Administrator, Federal Aviation for use by Mr. Jerome Lederer, Director Manned Space Flight Safety, National Aeronautics and Space Administration, June 5. 1968, 5pp.

2. Control Zones for All Instrument Approaches.

a. System Requirement. A need exists to establish control zones at airports having approved instrument approach procedures in order to provide an adequate degree of safety between aircraft executing instrument approaches and other, uncontrolled, aircraft.

b. System Description. Control zones are established to provide controlled airspace at airport locations having instrument approach procedures. Within control zones, all instrument flight rule (IFR) aircraft are provided standard IFR separation. In addition, when weather conditions are less than basic visual flight rule (VFR) conditions, aircraft not on IFR flight plans require clearances prior to entering or departing a control zone. Control zones are designated in Federal Aviation Regulations, Part 71, and extend upward from the surface of the earth. A control zone may include one or more airports and is normally a circular area with a radius of five statute miles and any extensions necessary to include instrument approach and departure paths.

c. System Goal. The goal is to establish control zones at all airports having approved instrument approach procedures.

d. Criteria for Implementation. Control zones are established at airports having instrument approach procedures if: (a) air/ground communications exist down to the runway surface with aircraft which normally operate at the airport, and (b) weather observations are taken and reported to air traffic control facilities. The criteria for the establishment of control zones are contained in FAA Handbook 7400.2, Procedures for Handling Airspace Matters, Part 200.

Instrument approach procedures are established whenever a reasonable need is shown. No minimum number of potential instrument approaches is required but, in the case of public procedures, it must be determined that the designation would be beneficial to more than a single user or interest. The criteria are contained in FAA Handbook 8260.3, United States Standard for Terminal Instrument Procedures (TERPS).

e. Bibliography.

(1) U.S. Congress, THE FEDERAL AVIATION ACT OF 1958, PUBLIC LAW 85-726, Washington, D. C., August 23, 1958, as amended (49 U.S.C. 1301 - 1541) Section 307(c).

(2) Federal Aviation Administration, PROCEDURES FOR HANDLING AIRSPACE MATTERS, An FAA Handbook 7400.2, September 1, 1965, Ch. 1 thru 17, 108pp.

(3) Federal Aviation Administration, UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES, An FAA Handbook 8260.3, September 1966, 200pp and appendices.

3. High Density Terminal Area (HDTA) Airspace.

a. System Requirement. A requirement exists for upgrading the safety of operation in high density locations through the establishment of a more standardized use of terminal airspace.

Today, even in the most congested terminal areas, flight operations are comprised of a mixture of IFR and VFR (controlled and uncontrolled) traffic. In this mixture, some flights are separated by the ATC system but frequently the pilot's ability to "see and avoid" is the primary tool for collision avoidance. When the speeds of today's aircraft and the ever increasing volume of traffic are considered, it becomes very apparent that the "see and avoid" concept of traffic

separation is obsolete in high density areas. This is forcefully brought out in the Near Mid-Air Collision Study covering the first 6 months of 1968. There were 371 terminal area near-miss reports which were considered as hazardous incidents. Most of these took place in the airspace at or below 3,500' AGL within 10 miles of an airport with a control tower. The majority involved aircraft in climb or descent, with one operating on an IFR flight plan and the other VFR and very good VFR weather existed in 95% of the situations. The report also brings out that the highest frequency of terminal incidents occurs generally in high density terminal areas.

b. System Description. To minimize reliance on the see and avoid concept of traffic separation, and to eliminate "unknowns," we are planning a reorganization of the airspace structure so that aircraft operating to and from the major airports are either segregated from all other aircraft or provided with separation by the air traffic control system. To accomplish this, we plan to establish special high density terminal airspace environments around major airports.

As envisioned at this time, the HDTA Airspace would be configured in three tiers and have a top of 10,000 feet. The bottom tier generally would coincide with the airport control zone and have a radius of five miles. The second tier would have a base of 2,200 feet (dropping to 1,200 feet along specified approach/departure corridors) and a radius of 10 to 15 miles. The third, or top, tier would begin at 5,000 feet and extend up to 10,000 feet with a radius of 20 to 30 miles.

The designated airspace normally would be used only by aircraft operating to and from the primary airport. All terminal traffic, both VFR and IFR, would then be contained in an environment which is totally controlled and from which unknown traffic would be eliminated by regulation. All aircraft entering this environment would be operated in accordance with an ATC clearance, regardless of weather conditions. Ingress/egress routes for the satellite, uncontrolled airports in the area would be provided, where feasible, to permit aircraft to avoid the designated airspace. The varying floors would permit free movement of uncontrolled traffic beneath the designated area.

Initially, this high density terminal airspace environment would not be true positive control airspace. There would be no requirement for the pilot to be instrument rated or for the aircraft to have a functioning transponder. Eventually, however, in accordance with the

overall plan for expanding positive control airspace, this terminal airspace environment would be designated terminal positive control airspace. In addition, there would be positive control tubes of transition airspace extending outward from the perimeter of the terminal positive control airspace connecting the terminal airspace with the overlying en route positive control area and positive control airways.

Initially, the following requirements would be established for operation within a designated HDTA:

Weather Minima: No VFR operations would be permitted at the major hub airport unless the reported ceiling was at least 1,500 feet and the ground visibility at least 3 miles.

Aircraft Equipment: All aircraft operating to and from airports within the HDTA would be equipped with a VOR receiver and have the capability to communicate on specified control frequencies. (Following initial implementation, it is anticipated that all aircraft would also be required to be equipped with an operable coded radar beacon transponder).

Pilot Requirement: Pilots would need at least a private pilot's certificate; no student pilots would be permitted at the designated airports.

c. System Goal. The goal is to establish HDTA Airspace at the following major terminals by 1970:

(1) JFK International
(2) LaGuardia
(3) Newark
(4) Chicago O'Hare
(5) Washington National
(6) Atlanta
(7) Los Angeles

By 1972, HDTA's should be established at all locations which meet the criteria.

d. Criteria for Implementation. The HDTA Plan, as originally developed, was to allocate airspace with more strict regimentation in major terminal areas to provide the greatest protection to the greatest number of people. The criteria for designation, therefore, was based on a combination of factors which considered the volume of people in the airspace as well as the volume of aircraft. It is expected that

locations would qualify on the criteria of 2.5 million annual enplaned passengers, 100,000 annual itinerant operations, and 100,000 annual instrument operations.

At any other airport which is classed as a large hub, but which does not meet the above criteria, the airspace configuration would not include the 5,000 - 10,000 foot tier.

e. Bibliography.

(1) Federal Aviation Administration, SPECIAL STUDY GROUP REPORT ON HIGH DENSITY TERMINAL AREAS, FOR OFFICIAL USE ONLY, February 1, 1968, 25pp and attachment.

(2) Federal Aviation Administration, PROPOSED PLANS FOR HIGH-DENSITY TERMINAL AREAS, March 7, 1968, 8pp.

(3) Federal Aviation Administration, NEAR MID AIR COLLISION STUDY REPORT SIX MONTH INTERIM REPORT-1968, September 13, 1968, 16pp.

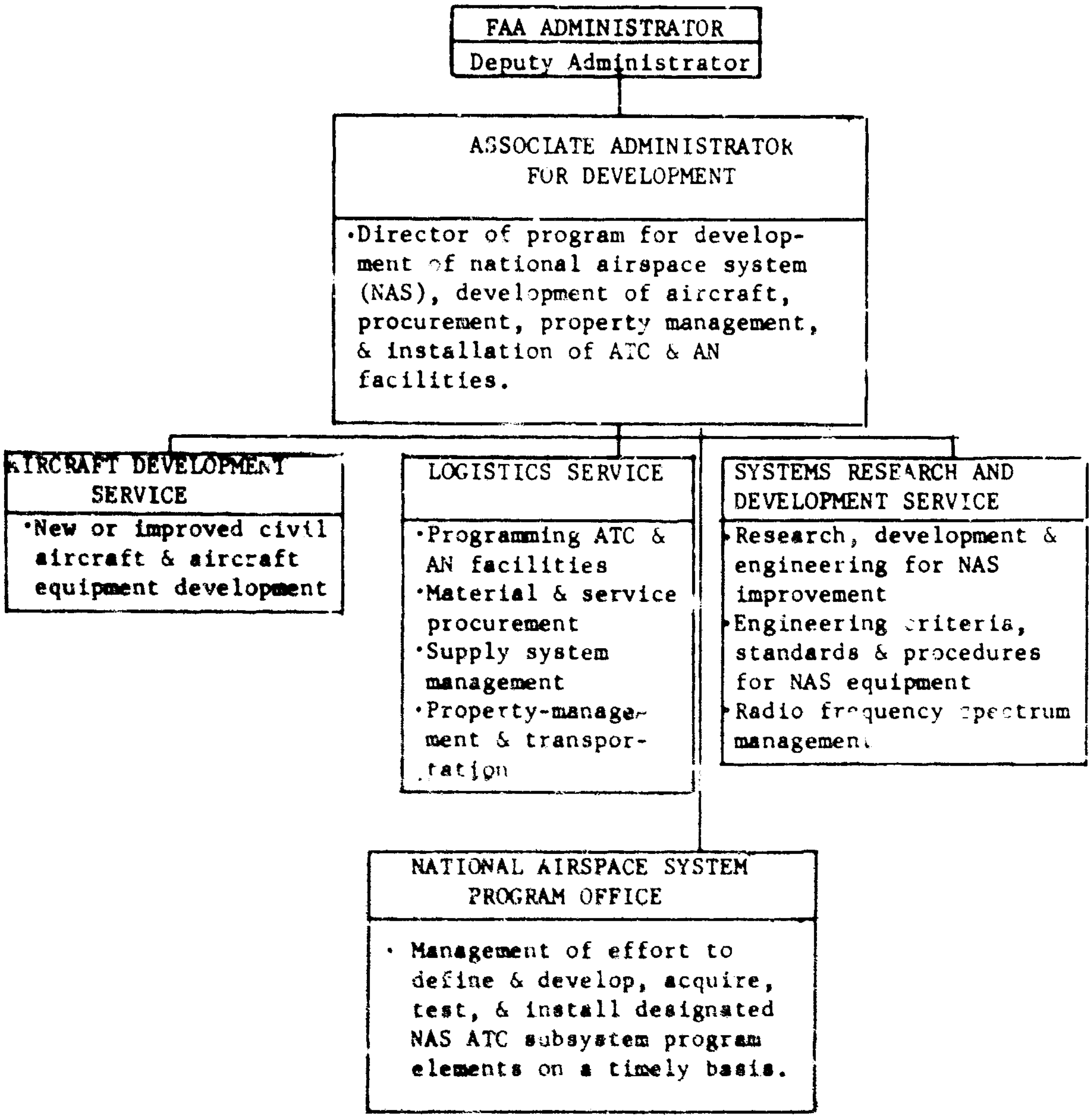
CHAPTER 5. RESEARCH AND DEVELOPMENT

a. System Requirement. The FAA Act of 1958 states that, "the Administrator shall develop, modify, test, and evaluate systems, procedures, facilities, and devices, as well as define the performance characteristics thereof, to meet the needs for safe and efficient navigation and traffic control of all civil and military aviation except for those needs of military agencies which are peculiar to air warfare and primarily of military concern, and select such systems, procedures, facilities and devices as will best serve such needs and will promote maximum coordination of air traffic control and air defense systems."

A requirement exists to conduct a balanced research, development, test, and evaluation program to modernize the air traffic control system and develop those system solutions that will best meet the immediate and long range needs.

b. System Description.

(1) The FAA research and development effort is conducted under the direction of the Associate Administrator for Development.


FAA ADMINISTRATOR
Deputy Administrator
ASSOCIATE ADMINISTRATOR FOR DEVELOPMENT
•Director of program for development of national airspace system (NAS), development of aircraft, procurement, property management, & installation of ATC & AN facilities.
AIRCRAFT DEVELOPMENT SERVICE
•New or improved civil aircraft & aircraft equipment development
LOGISTICS SERVICE
•Programming ATC & AN facilities
•Material & service procurement
•Supply system management
•Property-management & transportation
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
•Research, development & engineering for NAS improvement
•Engineering criteria, standards & procedures for NAS equipment
•Radio frequency spectrum management
NATIONAL AIRSPACE SYSTEM PROGRAM OFFICE
• Management of effort to define & develop, acquire, test, & install designated NAS ATC subsystem program elements on a timely basis.

(2) Test and Evaluation Support for the Research and Development effort is provided by the National Aviation Facilities Experimental Center (Atlantic City, N. J.) and the Aeronautical Center (Oklahoma City, Okla.).

FAA ADMINISTRATOR
Deputy Administrator

AERONAUTICAL CENTER	NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER
• General training operations • Aircraft fleet maintenance & modification • Aeromedical research & medical certificates • FS technical studies & airman examinations • Aircraft & airman records	• Test and evaluation supporting research & development activities • Aircraft fleet maintenance

(3) The FAA research and development plan is (organized under the headings) of: (1) air traffic control, (2) navigation, (3) aviation weather, (4) aircraft safety, and (5) aviation medicine. It is further divided into three categories, (a) In-Service Improvements, (b) System Modernization, (c) Long Range Research.

(4) In-Service Improvements. This category of the Air Traffic Control activity is oriented toward maintaining the current operating system at maximum possible efficiency, relieving immediate and recurring field problems, and facilitating an orderly transition from the current system to a modernized system to satisfy increasing demands of airways users.

(5) System Modernization. Within this category, emphasis is placed on efforts to expedite development and implementation of an automated air traffic control system. Modernization of air traffic control components of the national aviation system will be accomplished through development of improvements to facilities, equipment, techniques and procedures.

(6) Long Range R&D. Within this category of the ATC activity, programs stress the need for study of advanced procedures, techniques and concepts applicable to the National Airspace System and to analysis of all facets of aviation or of technological breakthroughs to assess potential impact on Air Traffic Control in the post-1975 time period.

c. System Goal. The immediate goal is to achieve modernization of the National Airspace System through improvements in facilities, equipment, techniques, concepts, and procedures.

The establishment of realistic goals, however, must take account of constraints imposed by current state-of-the-art in technology, funds made available, and judgment of the Congress and the public. There must be a high order of consistency between FAA responsibilities as prescribed by law and the goals established to meet these responsibilities. The requirement for safety in transit of the airspace leads to a goal of maintaining spatial segregation between controlled and uncontrolled aircraft. Another goal is to seek the optimum balance of ground based facilities and airborne equipment. Associated with this goal is the related one to provide the required service at minimum cost. It is important to recognize that these goals as well as others must be reflected in the system design and the research, development and implementation plans to fulfill the design.

d. Criteria for Implementation. The FAA research and development program is conducted in response to formal statements of requirements submitted by all elements of the FAA and public or private sources with an interest in aviation. The Associate Administrator for Programs maintains a revisable Register of Requirements.

Statements of major requirements are prepared in the form of an FAAR (Federal Aviation Administration Requirement). Minor requirements are stated on form 9550-1 (Request for Research, Development, Engineering Effort not affecting the NAS Register of Requirements).

The basic written document, prescribing the work to be performed, is called a subprogram or Schedule I. The subprogram contains a statement of requirement, description of effort, project responsibility, manager, and a schedule of time and costs.

Subprograms are reviewed continuously to validate the requirement and ensure successful prosecution of the work effort. Support from NAFEC is obtained by the preparation of a project Schedule II which represents an agreement between SRDS and NAFEC to provide test and evaluation assistance.

Support is also obtained for the subprograms through contracts with qualified firms, universities, and other government agencies.

e. Bibliography.

(1) U.S. Congress, THE FEDERAL AVIATION ACT OF 1958, Public Law 85-726, Washington, D. C., August 23, 1958 as amended (49 U. S. C. 1301-1541)

(2) Federal Aviation Agency Research and Development Service, DESIGN FOR THE NATIONAL AIRSPACE UTILIZATION SYSTEM, First Edition, G.P.O., Washington, D. C., June 30, 1962, 450pp.

(3) Federal Aviation Agency, NATIONAL AIRSPACE SYSTEM MANAGEMENT HANDBOOK, Agency Handbook 1800.1, Washington, D. C. 9-2-65.

(4) Federal Aviation Agency, REQUESTS FOR RESEARCH, DEVELOPMENT, AND ENGINEERING EFFORT, Agency Order 9550.1, Washington, D. C. 3/3/67

(5) Federal Aviation Agency, EXTERNAL TECHNICAL PROGRAM DOCUMENT, Systems Research and Development Service, Washington, D. C., July 1, 1968

BOOK 1
1/27/69

PART IV - AIR NAVIGATION

PART IV - AIR NAVIGATION

INTRODUCTION

1. Requirement - General.

The agency has a statutory responsibility to provide (develop, procure, install, and operate) within the limits of appropriations by Congress a system of ground based navaids. These facilities will enhance the safe and efficient utilization of airspace and the effectiveness of air traffic control by making available to pilots and controllers an electronic environment of common references for position reporting, routes of flight, departure and landing guidance under all types of weather and ground siting conditions. Present agency policies call for extending these services to new airspace segments, airports, and runways as justified by increasing traffic and for improving safety and reliability of operation. Inherent technical limitations of existing navaids inhibit long term dependence on current technology to meet future service needs. Long range agency requirements include the investigation of advances in technology for the purpose of selecting alternate or replacement systems in order to improve the quality, effectiveness, and reliability of navaid services to airspace users.

2. Criteria - General.

a. Quantitative (traffic density, climatology, etc.) where applicable.

b. Justification or rationale - peculiar siting conditions, airport configuration, aircraft types (jets, STOL).

Current agency planning standards provide a rational basis for justifying the addition of navaids through use of traffic counts and/or weather conditions. Future changes in implementation criteria will be required to accommodate new aircraft types and increasing demands for improved regularity of service at smaller airports.

Upgrading of facility performance, such as installation of more complex ILS antenna systems for permitting safe operation under

lower weather minima, will be predicated on traffic counts.

Improvements of enroute navaids are justified as "system requirements" rather than individual facilities because of external influences (buildings, power lines, etc.).

Justification for exploration of new techniques required to meet changing facility environment are determined by net effects on users, i.e., operational restrictions due to uncontrolled building activities in the vicinity of navaids.

Development of new systems for meeting new operational needs resulting from introduction of aircraft with different performance profiles and for replacement systems is based on cost/effectiveness considerations, agency/industry agreements, safety aspects and traffic capacity deficiencies.

CHAPTER 1. ENROUTE NAVIGATION AIDS

1. VORTAC.

a. System Requirement. All-weather navigation guidance of aircraft requires a system of reference signals to determine bearing and distance from fixed points on the ground. Such navaids are required in number and location to meet operational requirements of airspace users in order to permit aircraft to execute selected flight plans and to comply with directions of traffic controllers.

There is a need to improve the performance quality of VORTAC facilities through the implementation of in-service improvements to signal generation, monitoring and radiating components, replacement of older vacuum tube equipments with solid state counterparts and other "state of the art" programs. There is a requirement to continually reassess the distribution of VORTAC facilities in order to determine needs for relocation to meet projected traffic loads, elimination of redundant facilities and establishment of new facilities.

b. System Description. Principal types of short distance enroute aids installed and operated by FAA are:

(1) VOR. This facility operates in the 108-118 MHz band and provides azimuth information from a fixed ground point. Signal coverage of VOR and TACAN are limited to line of sight distances and are also affected by interference due to the necessity of repeating use of frequencies. Careful selection of sites is required for proper operation of standard VOR equipments. Where suitable sites are not available in a locality where a facility is urgently needed, special radiating systems such as those based on Doppler principles are available. Most VOR facilities are also provided with voice modulation in order to transmit weather broadcasts and replies to aircraft calls.

(2) TACAN. This is a pulsed navigation system which operates in the 900-1200 MHz band and provides both azimuth and distance information. TACAN azimuth information with range

and accuracy comparable to VOR is utilized mainly by military services. TACAN distance information is also utilized by civil aircraft in conjunction with VOR azimuth.

(3) VORTAC. A high percentage of VOR and TACAN facilities are co-located to provide a common reference for navigation information, and the combined facility is designated as a VORTAC.

(4) VOT. This is a radiated test signal source for verifying accuracy of airborne VOR equipment.

c. System Goal. The goal of the agency is to provide a short range navigation system adequate to meet the operational requirements of airspace users, and to meet agency criteria. Current plans include selective application of in-service improvements to facilities with performance deficiencies. Among these are modified VOR antenna systems such as Doppler and vertical stacked arrays which are less sensitive to uncontrolled construction or vegetation growth in critical zones. Facilities will be relocated when necessary due to expiration of land leases, to provide coverage of new airway segments serving newly constructed airports, or to accommodate new traffic procedures. VOT facilities will be provided at airports with significant aviation activities.

d. Criteria for Implementation. The VOR/VORTAC facilities comprise the primary U. S. system for short range navigation. Existing airways and existing or programmed VOR/VORTAC's satisfy most of the current and foreseeable coverage requirements. IFR navigation capabilities between existing enroute structures and candidate terminals will be provided when the terminal has more than 200 annual instrument approaches, 1825 or more passenger originations, or an active military base which requires enroute navigation facilities to accomplish its mission or to provide safety.

Additions, deletions, or modifications to the existing facility inventory will be justified on an individual facility basis as follows:

(1) Where radiation patterns are being distorted by uncontrolled construction subsequent to establishment of a facility, and continuation of service due to strategic site location is essential for traffic handling procedures, modified antenna

arrays such as Doppler or vertical stacked elements will be utilized to permit continuation of service.

(2) Where land leases are scheduled to expire and condemnation of real property is not feasible or appropriate, facilities will be relocated to suitable alternate sites.

(3) Where VOR facilities are utilized entirely for civil traffic, they will be equipped with DME in lieu of TACAN.

VOT criteria: Where airports have 50,000 or more annual itinerant operations, if certified VOR ground checkpoints are not available or capable of being established.

e. Bibliography.

(1) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE - TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, FAA Handbook 7031.2, Washington, D. C. , May 1965, 19 pp.

(2) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER TWO - AIR TRAFFIC CONTROL, FAA Handbook 7031.3, Washington, D. C., July 1965, 9 pp.

(3) Federal Aviation Agency, Systems Research and Development Service, VORTAC PERFORMANCE IN A SNOW AND ICE ENVIRONMENT, SRDS Report No. RD-68-3, February 1968, prepared by Scanwell Laboratories, 138 pp.

2. Precision VOR (PVOR).

a. System Requirement. Due to increased volumes of traffic in congested airspace segments, there are requirements to designate additional routes which in turn demand greater accuracy of azimuth information than that presently available from existing enroute navaids. The standard VOR design allows a maximum course error of $\pm$ 2.5 degrees for commissioning, while airborne equipment and pilot proficiency contribute additional elements of error which are governing factors in determining current standards for separation of designated airways. In order to achieve substantial reductions in spacing of airways, ground facility course errors must be minimized considerably, to the

order of $\pm$ 0.5 degrees, with comparable improvements in airborne system accuracy.

b. System Description. FAA has developed a modified VOR design which retains compatibility with the existing inventory of enroute facilities as far as reception by conventional airborne receivers is concerned, but in addition provides higher accuracy course information when received by suitably designed or modified airborne equipment to provide a many-fold improvement in course accuracy. This is accomplished through the addition of special modulation signals and the use of a wide aperture transmitting antenna array similar to Doppler VOR facilities. The resulting precision VOR (PVOR) facility is similar to the Doppler VOR in being essentially independent of disturbing influences from surrounding reflection surfaces while providing the capability of greater signal accuracy than is possible with the conventional Doppler facility.

c. System Goal. The agency goal is to provide electronic guidance for additional traffic routes in areas of heavy and increasing air traffic and to enable pilots to execute precise flight maneuvers with little or no intervention on the part of radar traffic controllers. These new routes will increase the capacity of enroute airspace segments and improve overall management of air traffic.

d. Criterion for Implementation. PVOR facilities will be established along high density route segments to provide precision enroute navigation guidance where traffic demands exceed the capacities of available routes based on conventional navaids.

e. Bibliography.

Federal Aviation Administration, Systems Research and Development Service, PRECISION VOR, VOLUME 1, DEVELOPMENT AND TEST PROGRAM, Report RD-67-58, August 1967, prepared by Airborne Instruments Laboratory, 40 pp.

3. V/STOL Enroute Navigation.

a. System Requirement. There is a requirement to provide enroute navigation service in airspace segments and at altitudes designated for use by these types of vehicles. Maximum use will be made of enroute navaids provided for fixed wing aircraft, and special

facilities or types of facilities will be installed as necessary to supplement the existing inventory of VORTAC stations, particularly to provide adequate transition to terminal navaids serving special landing areas for such aircraft.

b. System Description. At present there are no specific documented requirements for V/STOL enroute navigation which cannot be met with existing or specially sited conventional enroute navaids.

c. Goal. The agency goal is the establishment of a short range navigation system which meets the operational requirements of airspace users utilizing V/STOL vehicles.

d. Criteria. No criteria have yet been determined for special enroute navaids to serve the needs of V/STOL operators.

e. Bibliography.

Federal Aviation Agency, Systems Research and Development Service, VORTAC ERROR ANALYSIS FOR HELICOPTER NAVIGATION, NYC AREA, SRDS Report RD-66-46, July 1966, Atlantic City, N. J., 39 pp.

4. Area Navigation.

a. System Requirement. There is a requirement to provide greater flexibility in establishment of flight routes. Quality of existing navaids and airborne equipment must be improved to provide pilots with capabilities for unassisted "area navigation" over a variety of routes and traffic patterns which are not dependent on exact locations of ground facilities.

b. System Description. Area navigation is a concept of navigation based on use of signals from ground facilities whose locations are not identical with respect to desired flight patterns. This type of navigation is flexible since new flight procedures can be designated or changes made to procedures without requiring facility relocations or modifications in either ground or airborne equipments. Area navigation involves use of an airborne computer for processing navigation signals from ground facilities into steering information. Several forms of computer and display equipment have been developed for this purpose.

c. System Goal. The agency will continue to encourage development and user implementation of airborne equipment for area navigation.

Specific ground facilities which do not provide adequate coverage or quality of radiated signals necessary for area navigation will be identified and corrective programs initiated as appropriate.

d. Criteria for Implementation. Specific VORTAC facilities will be upgraded to provide adequate signal coverage and navigational data accuracy for area navigation applications. This will include installation of special radiating systems, facility relocation, and elimination of course irregularities.

e. Bibliography.

(1) Federal Aviation Agency, Systems Research and Development Service, AREA COVERAGE DISPLAYS AND COURSE LINE COMPUTER EXPERIMENTATION, SRDS Report RD-65-117, October 1965, Atlantic City, N. J., (Adams, Brandewie and Harter), 43 pp.

(2) Federal Aviation Agency, Systems Research and Development Service, STUDY OF PILOT ABILITY TO FLY HOLDING PATTERNS UTILIZING VARIOUS NAVIGATION TECHNIQUES, SRDS Report [illegible], February 1962, Atlantic City, N. J., (R. Byron Fisher, et al), 55 pp.

(d) Federal Aviation Administration, Systems Research and Development Service, ANALYSIS OF VECTOR ANALOG COMPUTER, SRDS Report RD-67-37, June 1967, prepared by Electro Technical Analysis Corporation, 128 pp.

5. Future Concepts, Systems.

a. System Requirement. Air traffic growth trends require development of new navigation concepts with greater accuracy and utility than current designs. Due to the existing large capital investments in ground and airborne equipments by the agency and airspace users, and the lengthy international coordination process involved in changeover to a new navigation system, development of a new system should begin immediately. Future requirements for navigation services by all classes of airspace users, the influence of navigation capabilities on air traffic control system performance, and spectrum utilization are considerations which new systems concepts must accommodate.

b. System Description. Characteristics of the succeeding generation of short range navaids are not known at this time.

c. System Goal. The agency will identify future requirements for enroute navaid performance and their influence on air traffic control effectiveness, and develop new navigation systems. Operational performance capabilities and economic aspects from the standpoint of agency resources as well as airspace user costs will be analyzed for candidate systems.

d. Criteria. Criteria for implementation of new types of short distance navaids have not been developed.

6. Long Distance Navigation Aids.

a. System Requirement. There is a requirement for a long distance navigation capability to provide service overwater and other areas, where the short distance capability cannot be provided with sufficient accuracy and responsiveness to safety, and efficiently serve the air traffic control system and the operators of high speed aircraft in both the domestic and overwater routes.

b. System Description. Long distance externally based navigation aids are utilized to provide service overwater and other areas where short distance aids cannot be provided (1) for general navigation service and/or (2) for navigation data for self-contained aids. The external reference radio navigation systems may comprise of Loran, Dectra, Consol, Omega, Radio Beacon or Satellites although the candiuates considered most promising for future international standardization are Loran, Satellites or Omega radio navigation systems.

A complementary relationship is recognized between the externally based long distance radio aids and the self-contained aids such as Doppler and inertial in the system of navigation and traffic control. However, the self-contained Doppler and inertial navigation systems are capable of operational performance which indicates that the external referenced radio aids may be limited to periodic updating or surveillance functions. Individual operators over certain long distance routes may rely on celestial observation and air data for navigation.

c. System Goal. In 1958 the Air Coordinating Committee, documents ACC 58/12.1B and 58/91 established the goal of a single national and international standard for ground based radio aid which would

be suitable for all users, including air, surface and sub-surface. It recognized the complementary relationship between ground-based short distance, long distance and self-contained aids, and supported implementation of interim aids pending a single world-wide solution. Another goal is to continue development and evaluation efforts towards developing an optimum long distance navigation system.

d. Criteria. No criteria have been developed for implementation of the long distance navigation system.

e. Bibliography.

(1) Air Coordinating Committee, AN CONF./4 AGENDA ITEM 9, LONG DISTANCE NAVAIDS, ACC 58/91 ICAO DOC. 8554.

CHAPTER 2. TERMINAL NAVIGATION AIDS

1. Instrument Landing System (ILS).

   a. System Requirements. There is a requirement to provide vertical and lateral guidance to aircraft when approaching a runway for landing under VFR and IFR weather conditions.

   There is a need to improve the performance and reliability of ILS and to incorporate electronic state-of-the-art techniques. In-service improvements are required in the ILS localizer and glide slope antenna systems to minimize site and weather effects which now restrict operations at some locations. There is also a need to develop fail-safe systems for Categories II and III operations.

   b. System Description. The ILS is composed of a Localizer, Glide Slope and Marker Beacons. The localizer is an electronic unit which transmits radio signals along the extended centerline of a runway and which provides lateral guidance data to aircraft equipped with appropriate airborne receivers. The glide slope is a similar unit except it transmits a signal which provides vertical guidance data to the aircraft. The glide slope data establishes guidance for a flight path normally between 2.5° and 3° with the horizontal.

   Marker beacons are electronic units which transmit a vertical signal to an airborne receiver which identifies passage of the aircraft over designated points along the flight path. The outer marker is normally located at the distance from the runway threshold where an aircraft at the initial approach altitude would intercept the glide slope flight path signal. The middle marker is located at a distance corresponding to the 200-foot altitude point on the glide slope.

   On Category II installations, only, there is also an inner marker located at a distance corresponding to the 100-foot altitude point on the glide slope.

   The ILS also includes an approach light system and medium or high intensity runway lights. In Category II operations, RVR centerline and touchdown zone lights are required. These lighting aids are described under the section on Visual Aids.

c. System Goal. It is the goal of the agency to provide nonvisual vertical and lateral guidance equipment for all runways in the United States which meet agency criteria.

d. Criteria for Implementation.

(1) At airports where scheduled air carrier operations are conducted on a sustained basis or at any general aviation airport which records 700 or more annual instrument approaches, provided that:

(a) A comprehensive evaluation of the runway to be served by the ILS indicates that the operations to be conducted will be safe and type(s) of aircraft which will use, or are forecast to use, the ILS can be accommodated safely on the existing runway.

(b) High intensity runway lights (HIRL), or, if appropriate, medium intensity runway lights (MIRL) are installed or programmed. If runway visual range (RVR) equipment will be used, HIRL must be installed or programmed.

(c) The approach light system installed shall be either the MALS/RAIL, SSALS/RAIL, or ALS/SFL.

(d) At general aviation airports, installation of the ILS with approach lights will reduce landing minimums to a 300-foot Decision Height (DH) and 3/4 mile visibility (300 DH/3/4) or lower and a climatology study indicates that the lower minimums will significantly reduce the number of missed approaches, diversions, cancellations, and delays.

(e) The ILS installed shall normally have single electronic equipment unless a special study justifies installation of dual electronic equipment. For an ILS installed at the primary air commerce airport(s) in a large hub area on any runway which has 700 or more annual instrument approaches, dual electronic equipment shall be considered justified. Normally, an ILS already commissioned having dual electronic equipment shall not be reduced to single equipment unless such reduction is justified by a special study.

e. Bibliography.

(1) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE - TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, FAA Handbook 7031.2, Washington, D. C., May 1965, 19 pp.

(2) Federal Aviation Agency, Systems Research and Development Service, DESIGN FOR THE NATIONAL AIRSPACE UTILIZATION SYSTEM, Washington, D. C., June 30, 1962, 450 pp.

(3) Federal Aviation Administration, STAFF STUDY OF COSTS VS. BENEFITS OF AIRPORT APPROACH AIDS, Coordination Draft, Washington, D. C., August 18, 1967, 57 pp.

(4) Federal Aviation Administration, STAFF STUDY OF COSTS AND BENEFITS OF ALL-WEATHER LANDING SYSTEMS (AWLS), Coordination Draft, Washington, D. C., September 14, 1967, 37 pp.

(5) Federal Aviation Agency, COMPARATIVE COST ANALYSIS OF CONVENTIONAL AND MARK I ILS INSTALLED AT TYPICAL MAJOR AIR TERMINAL AND TYPICAL LOW DENSITY AIRPORT, Memorandum Report, Project No. 320-101-02R, Washington, D. C., March 1967, 11 pp.

(6) Department of Transportation, REMARKS PREPARED FOR ALAN S. BOYD, BEFORE THE SENATE COMMERCE COMMITTEE, AVIATION SUBCOMMITTEE, Washington, D. C., June 18, 1968.

2. Terminal VHF Omnirange (TVOR).

a. System Requirement. The TVOR is used to provide guidance for aircraft to or from an airport during low approaches to the field for landing during VFR and IFR weather down to 400-foot ceiling and 1 mile visibility. Although weather minima for TVOR approaches are higher than for ILS, these facilities provide low cost approach and landing aid service suitable for many low density airports. Increased utilization of TVOR's and VOR's as an approach aid, when combined with DME, is described in the following section on DME.

There is a requirement for a short range navigation device to provide bearing guidance to aircraft at airports which are not provided navigation coverage from the enroute VORTAC system. This guidance is required for IFR approaches to low density airports which do not have other suitable navigation aids.

b. System Description. The TVOR is an electronic transmitter which provides bearing signals to aircraft equipped with suitable airborne receivers. It is similar in construction and function to the standard VHF VOR except it is lower powered and is shorter in range coverage. The TVOR is often used as an enroute aid as well as an aid for making approaches to airports.

c. Systems Goal. It is the goal of the agency to increase the utilization of the airspace in poor weather conditions by providing approach and landing guidance to airports which meet agency criteria but do not qualify for an ILS.

d. Criteria for Implementation. A general aviation airport with 200 or more annual instrument approaches or 1,825 or more scheduled annual passenger originations (as recorded in validated counts acceptable to the FAA) is a candidate for the following terminal instrument approach system (single equipment) when the existing instrument approach procedure and associated navigational aids do not provide landing minimums of a 400-foot minimum decision altitude (MDA) and one-mile visibility (400 MDA/1) or better.

TVOR: A 75 MHz marker beacon may be considered at new or existing TVOR locations provided an individual justification indicates that it is necessary in order to achieve 400 MDA/1 minimums. A DME (single equipment) may also be considered for new or existing TVOR locations provided that an individual justification indicates that it will provide more efficient handling of traffic, or a reduction of the adverse effect of obstructions on landing minimums, or an otherwise tangible improvement in the IFR capability of the airport. A TVOR may be installed when:

1. An instrument approach procedure is not possible from an adjacent VHF navigational aid.

2. The existing instrument approach procedure is based on an L/MF navigational aid.

3. The adjacent VHF navigational aids would not provide transition to a localizer.

e. Bibliography.

(1) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE - TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, FAA Handbook 7031.2, Washington, D. C., May 1965, 1? pp.

(2) Federal Aviation Administration, STAFF STUDY OF COSTS VS. BENEFITS OF AIRPORT APPROACH AIDS, Coordination Draft, Washington, D.C., August 18, 1967, 57 pp.

(3) Federal Aviation Agency, COMPARATIVE COST ANALYSIS OF CONVENTIONAL AND MARK I ILS INSTALLED AT TYPICAL MAJOR AIR TERMINAL AND TYPICAL LOW DENSITY AIRPORT, Memorandum Report, Project No. 320-101-02R, Washington, D.C. March 1967, 11 pp.

(4) Department of Transportation, REMARKS PREPARED FOR ALAN S. BOYD, SECRETARY OF TRANSPORTATION, BEFORE THE SENATE COMMERCE COMMITTEE, AVIATION SUBCOMMITTEE, Washington, D.C. June 18, 1968.

3. Distance Measuring Equipment (DME).

a. System Requirement. In addition to the DME requirement as an integral part of VORTAC facilities, there is a need to furnish distance information to aircraft at airport approach facilities where marker beacons are impractical, or where continuous distance from a fixed reference point is required for the safe operation of aircraft. There is a need for DME at selected TVOR facilities to provide for a non-precision computed approach capability.

There is also a requirement for precision DME at ILS facilities for Category III operations.

b. System Description. The process of measuring distance is initiated by the generation of a pulsed signal (an interrogation) in the correct frequency and pulse spacings, they are accepted by the ground transponder. It in turn generates the pulsed signal (reply) that is radiated back to the airborne receiver. Distance is computed by measuring the total time for the round trip journey of the interrogation and its reply.

VOR/DME can provide a completely new range of flexibility in approach procedures for instrument approach capability at low density airports. The desired glide slope for multiple or single runways can be computed from altimetry and measured to a runway end. A course computer in the aircraft can also be used to provide azimuth information related to the runway centerline as derived from a nearby VOR/DME. Although the precision achieved by the VOR/DME is not likely to be as great as a glide slope installation, the flexibility of the arrangement may be sufficient justification to consider its use for low density airports at or near an available VORTAC facility.

c. System Goal. It is the goal of the agency to provide DME service collocated with ILS at selected jet airports and at smaller airports collocated with TVOR where computed approach guidance is required for the safe operation of aircraft.

d. Criteria for Implementation.

(1) A DME (single equipment) may be installed with an ILS in lieu of a marker beacon when significant operational benefits will result from the use of this facility at locations where geographical or operational environment is such that no final approach fix can be economically sited or transition to the ILS cannot be made using adjacent navigation aids and procedures and operations will be simplified.

(2) An ILS airport recording 1,400 or more annual instrument approaches is a candidate for a DME facility when.

(a) Lower landing minima will be authorized in accordance with applicable agency instrument approach criteria; and,

(b) A climatology study indicates that the DME will provide a significant reduction in the number of missed approaches, cancellations or diversions; or,

(c) The DME will significantly expedite the flow of IFR air traffic arriving and departing the airport.

(3) ILS airports with between 700 and 1,399 annual instrument approaches may be considered for a DME facility when an individual location study indicates the DME will result in a sufficient number of additional completed approaches that is commensurate with the cost of the facility.

(4) A DME (single equipment) may also be considered for new or existing TVOR locations provided that an individual justification indicates that it will provide more efficient handling of traffic, or a reduction of the adverse effect of obstructions on landing minimums, or an otherwise tangible improvement in the IFR capability of the airport.

e. Bibliography.

(1) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE - TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, FAA Handbook 7031.2, Washington, D.C., May 1965, 19 pp.

(2) Federal Aviation Agency, Systems Research and Development Service, DESIGN FOR THE NATIONAL AIRSPACE UTILIZATION SYSTEM, Washington, D.C., June 30, 1962, 450 pp.

(3) Sandretto, Peter C., ELECTRONIC AVIGATION ENGINEERING, International Telephone and Telegraph Corporation, 1958, 755 pp.

4. V/STOL Approach and Landing.

a. System Requirement. The increased urbanization of the U.S. population has created a need for V/STOL air service as part of the expanding transportation system. Large metropolitan areas have the primary requirement for this service. The continued population growth of these areas and the accompany traffic congestion, together with a high level of demand for air transportation, places a premium on the provision of more convenient, timesaving, intra urban-suburban and short haul intercity air transportation.

If intercity V/STOL transportation is to be successful a high degree of operational reliability is required. Heretofore, helicopters used navigational facilities designed and sited for fixed-wing aircraft, which could have a limiting effect in the future applications of helicopters for IFR operations. If V/STOL aircraft are to fulfill their potential for operations into restricted landing sites, precision approach and landing aids capable of providing IFR guidance into such sites must be tailored to the unique flight characteristics of these aircraft.

b. System Description. The V/STOL approach and landing system has not yet been determined.

c. System Goal. It is the goal of the agency to provide an all weather approach system for V/STOL aircraft to aid in reducing the traffic congestion at the larger air terminals and metropolitan centers.

d. Criteria for Implementation. Implementation criteria have not yet been developed.

e. Bibliography.

(1) Department of Transportation, REMARKS PREPARED FOR ALAN S. BOYD, SECRETARY OF TRANSPORTATION, BEFORE THE SENATE COMMERCE COMMITTEE, AVIATION SUBCOMMITTEE, Washington, D.C., June 18, 1968.

(2) Federal Aviation Agency, DEVELOPMENT PROJECT PLAN FOR V/STOL APPROACH AND LANDING SYSTEM, Federal Aviation Administration System Requirement 6750.2, March 15, 1967.

5. Area Navigation.

a. System Requirement. Extensive use of radar vectors and close supervision by traffic controllers is currently necessary for insuring the safe execution of complex traffic patterns in high density terminal traffic areas. This type of controller workload needs to be minimized through implementation of area navigation by returning the terminal navigation capability to the cockpit and allowing controller workload to be directed toward radar monitoring and

assistance. Navaids of increased accuracy need to be developed or existing navaids improved to provide the required flexibility of route structures.

b. System Description. Area navigation is a concept of navigation based on use of data from ground facilities whose locations do not limit the development of desired flight patterns. This type of navigation is flexible since new flight procedures can be designated or changes made without requiring facility locations or modifications in either ground or airborne equipments. Area navigation requires the use of airborne computer/displays for reducing navigation signals from ground facilities into guidance for the pilot. Several forms of computer and display equipment have been fabricated for this purpose.

c. System Goal. The agency will continue to encourage development and user implementation of airborne equipment for area navigation. Ground facilities determined to need improvement, relocation, or replacement to provide the quality of radiated signals necessary for area navigation will be identified and corrective or development programs initiated as appropriate.

d. Criteria for Implementation. The criteria for implementation or improvement of ground facilities for area navigation has not yet been determined.

e. Bibliography.

(1) Federal Aviation Agency, DYNAMIC SIMULATION STUDIES OF PICTORIAL NAVIGATION DISPLAYS AS AIDS TO ATC IN LOW-DENSITY TERMINAL AREA AND IN AN EN-ROUTE AREA, Final Report, Project No. 115-703X, February 1963, 66 pp.

(2) Federal Aviation Agency, DYNAMIC SIMULATION STUDIES OF PICTORIAL NAVIGATION DISPLAYS AS AIDS TO ATC IN HIGH DENSITY AND MEDIUM DENSITY TERMINAL AREAS, Interim Report, Task No. 115-703T, November 1961, 89 pp. & appendices.

(3) Federal Aviation Agency, Systems Research and Development Service, AREA COVERAGE DISPLAYS AND COURSE LINE COMPUTER EXPERIMENTATION, SRDS Report RD-65-117, October 1965, Atlantic City, N. J. (Adams, Brandewie and Harter), 43 pp.

(.) Martin, Robert W., AREA NAVIGATION, presented at the RTCA 1968 Annual Assembly Meeting, September 25-26, 1968, 7 pp.

6. Visual Aids.

a. System Requirement. There is a requirement to provide visual guidance of aircraft in landing and taking-off, and for surface movements. They are needed for night operations, and for reduced visibilities both day and night. The principal components are approach lights, runway lights, and taxiway lights. Additional components, such as touchdown zone and centerline lights, are required for the much lower visibilities of Category II operations.

b. System Description. The visual aids used for terminal navigation comprise a unique system of special lights and painted markings which provide primary guidance for pilots in VFR operations and supplementary guidance when used in conjunction with non-visual aids during IFR operations. The visual problems encountered by pilots, and the lighting aids used for their solution include:

(1) Location and identification of the airport - airport beacons.

(2) Runway acquisition and alignment - approach lights.

(3) Determination of correct glide angle and approach attitude - visual approach slope indicator (VASI).

(4) Location and identification of runway threshold - by means of runway end identifier lights (REILS) and/or threshold lights.

(5) Determination of runway confines - runway edge lights.

(6) Determination of runway touchdown area - touchdown zone lights.

(7) Alignment, rollout, and takeoff guidance - runway centerline lights.

(8) Taxiing guidance - taxiway turnoff and taxiway centerline lights, edge lights, [illegible] taxi signs.

(9) Painted markings and stripes on runways, taxiways, and aprons for visual guidance when lights are not used, or lights are not available.

(10) **Provision of approach lighting in displaced threshold areas - improved flush approach lighting.**

c. System Goal. Generally, it is the goal of the agency to provide lighting and marking for all U.S. airports where the operational demands and requirements of safety are established and which meet agency criteria. Specifically, it is an agency goal to provide or cause to be provided by others an approach lighting system and medium or high intensity runway edge lights for each runway that qualifies for an instrument landing system (ILS). It is also an agency goal to provide additional lighting system components such as touchdown zone lights, runway centerline lights, and high speed taxi exit lights, at each jet runway for which Category II operations are planned.

d. Criteria for Implementation.

(1) Approach Lights. An approach light system shall be installed on each ILS equipped runway. The approach light system installed shall be one of the following:

(a) A Medium Intensity Approach Light System with Runway Alignment Indicator Lights (MALS/RAIL) if Category D* or larger aircraft are not forecast to serve the airport within five years.

(b) A Simplified Short Approach Light System with Runway Alignment Indicator Lights (SSALS/RAIL) if Category D or larger aircraft are forecast to serve the airport within not less than three, nor more than five years.

(c) A standard Approach Light System with Sequenced Flashing Lights (ALS/SFL) if the airport is served by Category D or larger aircraft or such service is forecast within three years.

(d) When more than one ILS is installed at an airport, the second approach light system shall be a MALS/RAIL unless a special study shows that a more sophisticated system is required for the intended operation.

(2) Runway End Identification Lights (REIL). (No reduction of IFR visibility minimums is authorized solely for new REIL installations.)

*As specified in the United States Standard for Terminal Instrument Procedures (TERPS).

(a) Establishment - An airport is a candidate for REIL when the runway for which it is proposed has lights, has 3,000 or more annual landings and a minimum safety rating of 90 as determined in a case by case analysis.

(3) Lighting Aids for Nonprecision Approach

(a) A general aviation airport with a nonprecision approach system installed or programmed which records 300 or more annual instrument approaches or 2,725 annual passenger originations is a candidate for a Medium Intensity Approach Light System (MALS) provided the installation will reduce landing visibility minimums.

(b) Alternatives:

1. A Simplified Short Approach Light System (SSALS) may be considered in lieu of MALS when valid forecasts indicate a reasonable probability that the airport will qualify for an ILS within two years and scheduled air carrier service using Category D or larger aircraft will be introduced within five years.

2. A Lead-In Lighting System (LDIN) may be installed in lieu of MALS if the non-precision approach aid does not permit a straight-in approach or operational conditions require a curved flight path to a specific runway.

(4) Visual Approach Slope Indicator (VASI). (No reduction of IFR visibility minimums is authorized for VASI installations. Except where unusual circumstances generate a requirement, a runway which has a glide slope installed or programmed is not eligible for any VASI installation.)

(a) Twelve-Box VASI

Establishment - A major airport at which Category D or larger aircraft operations are conducted is a candidate for a twelve-box VASI, when operationally required, for a runway which has 5,000 or more annual landings and a minimum safety rating of 90 as determined in a case-by-case analysis.

(b) Four-Box VASI

Establishment - An airport at which Category A, B and C aircraft, including jet operations are conducted, is a candidate for a four-box VASI when operationally required for a runway which has 5,000 or more annual landings and a minimum safety rating of 90 as determined in a case-by-case analysis.

(c) Two-Box VASI

Establishment - An airport at which no jet operations are conducted is a candidate for a two-box VASI when operationally required for a lighted runway which has 5,000 or more annual landings and a minimum safety rating of 90 as determined in a case-by-case analysis.

e. Bibliography.

(1) Federal Aviation Agency, AIRWAY PLANNING STANDARD NUMBER ONE - TERMINAL AIR NAVIGATION FACILITIES AND AIR TRAFFIC CONTROL SERVICES, FAA Handbook 7031.2, Washington, D. C., May 1965, 19 pp.

(2) Federal Aviation Administration, STAFF STUDY OF COSTS VS. BENEFITS OF AIRPORT APPROACH AIDS, Coordination Draft, Washington, D. C., August 18, 1967, 57 pp.

(3) Federal Aviation Agency (Administration beginning April 1967) FAA ADVISORY CIRCULARS, listed by number, title and date.

(a) AC 70-7460-1 - Obstruction Marking and Lighting (February 1968)

(b) AC 121-8 - Additional Airport Aids - Runway Marking and Lighting - Air Carrier Turbojet Operations (Sept. 19, 1966)

(c) AC 150/5340-13A - High Intensity Runway Lighting System (April 14, 1967)

(d) AC 150/5340-14A - Economy Approach Lighting Aids (March 7, 1967)

(e) AC 150/5340-15A - Taxiway Lighting System (November 1, 1967)

(f) AC 150/5340-16A - Medium Intensity Runway Lighting System (December 19, 1967)

(g) AC 170-1 - Operation and Use of Approved Lights (ALS) and Sequenced Flashing Lights (SFL) Systems (January 14, 1963)

(4) Federal Aviation Agency, AIRPORT LIGHTING, Technical Standard Order TSO-N24a, September 11, 1959

7. Visibility Measuring Systems.

a. System Requirement. There is a requirement for range of visibility along the runway for authorized landing of aircraft in poor weather conditions. Also, slant range visibility systems are needed for Category II and III requirements to provide a more precise measurement of visibility as seen by the pilot while actually making an approach and landing. Additional requirements that are necessary in other ground maneuvering areas include visibility systems for taxiways, heliports, etc.

b. System Description. Expressed in hundreds of feet, runway visual range (RVR) capitalizes on the increased guidance which intense runway lights give the pilot. It is determined from a transmissometer system installed along an instrument runway. As the runway light setting is changed by tower personnel, the transmissometer's computer system, wired directly to the lighting control, automatically converts the readout to a value based on the new light setting. Although a particular pilot may be able to see slightly more or less than the indicated runway visual range, this instrumentally derived measurement is normally more representative than an evaluation by eye based on visibility targets usually available.

Visibility measurements at airports are made visually by reference to the extent that objects on the ground of known distance away are visible and by more precise equipment known as RVR (Runway Visual Range). RVR readings are obtained from a transmissometer system which measures the visibility range along the runway taking into account the effect of visual aids such as HIRL.

Helicopter Visual Range (HVR) is a visibility value designed to provide the helicopter pilot with an indication of the height at which he can recognize specific landing reference points.

c. System Goal. It is the goal of the agency to provide RVR systems for each ILS runway (on airports served by a control tower) where warranted and to develop and implement visual range systems for heliports and STOL-ports. It is also an agency goal to provide instrumentation for determining visual range on taxiways supporting Category III operations.

d. Criteria for Implementation

New criteria for RVR has not yet received Agency approval. RVR is required on all designated or future planned Category II/III runways. Category I runways do not require RVR equipment unless a special requirement exists to satisfy an operational need and it is supported by a special climatology study. At those Category I locations, where a special study indicates that RVR is required, it will be necessary that a control tower and high intensity runway edge lights are installed.

e. Bibliography.

(1) Federal Aviation Agency, AN ANALYSIS OF RUNWAY VISUAL RANGE, Report No. RD-66-100, prepared by Environmental Science Services Administration, Weather Bureau, December 1966, 120 pp.

(2) Federal Aviation Administration, EVALUATION OF MULTI-TRANSMISSOMETER SYSTEMS, Report No. RD-68-49, prepared by Environmental Science Services Administration, Weather Bureau, August 1968, 192 pp.

(3) Federal Aviation Administration, VISUAL RANGE MEASUREMENTS, Federal Aviation Administration Requirement 5335.1, October 27, 1967.

(4) Federal [illegible] Administration, HELIPORT LIGHTING AND MARKING, Federal [illegible] Administration Requirement 5340.1, October 27, 1967.

8. Future Concepts, Systems.

a. System Requirement. There is a need to develop and implement a replacement ILS. It is desired that this replacement system meet the operational requirements regardless of siting and weather conditions. Also it is desired that the system be designed to meet the total requirement range, from the smaller airport to the most complex airport, by adding additional features through the "building-block" concept design.

b. System Description. The future system has not yet been determined.

c. System Goal. It is the goal of the agency to provide precision approach and landing guidance and control of aircraft in all weather environments at those locations that qualify under agency criteria. Also, it is a goal to continually keep abreast of terminal area navigation problems and to develop and implement fixes as required.

BOOK 1
1/27/69

PART V - COMMUNICATIONS

BOOK 1
1/27/69

PART V - COMMUNICATIONS

INTRODUCTION

History has repeatedly shown that the capability of any control system is only as good as its internal and external communications capability. A control system by definition performs three basic functions which may be broadly defined as: 1) the acquisition of information; 2) the organization of this information for a particular purpose; and 3) the dissemination of instructions to bring about the desired objective. The acquisition and dissemination of information requires communications which may be considered external to the heart of the system. In the air traffic control (ATC) system, this would represent communications to aircraft, weather offices, user offices, airports, flight service stations, and all other locations which supply information to or receive information from the ATC system. The organization of this information to control air traffic requires communications which may be considered internal to the system. In the ATC system this would represent communications between separate control facilities such as air route traffic control centers (ARTCCs) as well as between individuals and/or machines within a control facility such as an ARTCC, FSS, or control tower.

It must be recognized that the more sophisticated and complex the overall ATC system becomes, the more sophisticated and complex the supporting communications system becomes. A fundamental reason for increasing system sophistication is the increasing density of aircraft in a particular volume of airspace. Failure of the control process can have a serious effect on both the safety and efficiency of the system. A failure of the communications system will result in some degree of failure to the control system. The degree of control system failure will of course be dependent upon the nature and extent of communications systems failure and the alternate control procedures. A failure of a weather input circuit may have little immediate effect on the control system while a failure of an A/G radio circuit could have a severe impact on the ATC system. The communications system supporting ATC is vital, is an integral part of the ATC system, and must be designed with the same degree of reliability/redundancy.

While the overall performance of the communications system is not a limitation on the ATC and aeronautical services at the present time, there are several areas in which the communications system is working at or above normal capacity or is marginal in terms of reliability/redundancy. With the continued aviation growth and implementation of enroute and terminal automation there are several areas in which the communications system would become grossly inadequate unless system modernization is achieved.

The various areas or subsystems of the ATC and aeronautical services systems such as air/ground, point-to-point data, and voice recording are analyzed in the following paragraphs. Where the functions differ significantly because of type of facility (i.e., air/ground communications as related to ATCTs vs. ARTCCs) the differences are identified.

One of the most acute problems developing in the air/ground subsystem is frequency congestion. At the present time, in the normal case, every ATC function in every airspace segment requires the assignment of a discrete VHF frequency and, where appropriate, a UHF frequency. Thus the addition of a new facility such as an approach control, or the addition of an airspace segment such as a new sector, requires the addition of one or more discrete frequencies. The availability of channels is now acute in the northeastern and far western areas of the United States. In such areas it has not normally been possible to provide preferred interference protection and, in some cases, assignments can only be made by severe derogation of criteria. It is anticipated that this condition will not improve and that 50 kHz, 360 channel aircraft receivers are only capable of providing partial relief.

Another acute problem developing in the air/ground subsystem results from the changing nature of message content handled by the system. With the continued expansion and increase of traffic in controlled airspace, the percentage of routine communications, such as position reports, will continue to decline and the percentage of control instructions such as open-end vectors can be expected to increase. Furthermore, decreased lateral separation in the radar environment increases the urgency to achieve high reliability and immediacy of communications access. Air/ground communications are, therefore, becoming increasingly critical to safety and efficiency in the control system which, in turn, demands higher levels of reliability in the air/ground system than now exists--particularly in high density areas.

An area of concern in the air/ground subsystem is the communications workload imposed on the pilot and the controller. The pilot is more affected because the number of frequency changes per flight will increase as airspace is divided or additional functions are added to existing airspace segments. The controller has been less affected because such divisions and additions have usually been accompanied by an addition of control positions. However, controller workload is already known to be a limiting factor on channel utilization so that controller workload is increasingly becoming a matter of concern.

There are several other problems regarding the air/ground communications subsystem which are geographically distinctive. These problems involve the provision of air/ground communications in oceanic and sparsely populated land mass areas. The first is the state of Alaska, where the relative importance of air transportation is very high due to the lack of highway and rail networks. The same geographic and climatic conditions that inhibit building of adequate highway and rail networks make it very difficult and costly to build

and operate an adequate air/ground communications network, and increase the importance of air/ground communications as a matter of safety. The second problem is the provision of communications in international airspace typified by large oceanic areas. Where there is a lack of suitably located land, either long-range land-based communication techniques or artificial space or ocean surface platforms must be used to base other techniques. Although the existing land-based high frequency (HF) system is adequate at the present time in terms of safety, it is not adequate in terms of the reliability and quality required to accommodate traffic growth in international airspace. It is also recognized that HF radio cannot provide good quality direct pilot to controller communications which are required by the ATC system. Present international traffic estimates show that traffic movement in some areas will have to be penalized to maintain safety in about five to six years. In the event surveillance, or position fixing capability, were provided to permit continued reduction in separation standards, such reduction would necessitate the concurrent or earlier provision of more reliable air/ground communications.

A final problem is the cost of providing and maintaining the air/ground subsystem. If current techniques are used to expand the capacity of the existing system and provide the required reliability, the cost of the subsystem will soar. Fortunately, new techniques such as the use of solid state devices and an integrated system design can be expected to minimize any cost increases while significantly improving the system effectiveness.

In the discussion which follows, communications is treated as an independent subsystem. Obviously there is considerable interface between communications and air traffic control. Therefore, parts of this discussion overlap portions of the chapters on air traffic control.

CHAPTER 1. AIR/GROUND COMMUNICATIONS

1. Discrete Aircraft Frequency Concept.

   a. System Requirement. The increasing volume and speed of aircraft demand that an improved communication system be devised to reduce the communication burden on both the pilot and the controller in order to maintain the present standards of safety and efficiency.

   Immediate effort is required to ensure that the most efficient and effective communications system will evolve to meet projected requirements of the National Airspace System (NAS) and aircraft types and traffic volumes of the future.

   b. System Description. There is no agency approved system that will meet the total system requirement.

   c. System Goal. The goal is to provide a system which will reduce the controller communications workload by eliminating the need for frequency change messages and will reduce the air crew workload by eliminating the need to make frequency changes in the aircraft.

   d. Criteria for Implementation. Not yet developed.

   e. Bibliography.

(1) Federal Aviation Administration, FUTURE VOICE COMMUNICATION SYSTEM, System Requirement FAAR 7310.3, Washington, D.C., October 1, 1968

2. Air/Ground Backup System.

   a. System Requirement. The control of air traffic requires a continuous communications capability between controller and aircraft. The assurance of reliable air/ground (A/G) communications require that provisions be made for continued operation in the event of failure of the primary communications path. The most feasible provisions for reliability is a backup system utilizing completely redundant equipment operating over an assuredly redundant and geographically separated communications path. The early implementation of this backup system is necessary to remove the hazard potential caused by the loss of portions of the present A/G communications service.

   b. System Description. There is no agency approved system to meet the system requirement.

c. System Goal. The system goal is to provide redundant ground based air/ground channels to back up each RCAG facility should it experience a total failure.

d. Criteria for Implementation. A sufficient number of remote transceivers must be provided within the coverage volume of each RCAG so that redundant coverage is provided without reducing the capacity for simultaneous communications that exists at the RCAG facility.

e. Bibliography.

(1) Federal Aviation Administration, FUTURE VOICE COMMUNICATION SYSTEMS, System Requirement FAAR 7310.3, Washington, D. C., October 1, 1968

3. Air Traffic Control Air/Ground Communications In-service Improvements.

a. System Requirement. To meet the increasing demand for air/ground communication caused by the increase in air traffic it is necessary to modify, expand, and rearrange equipments that make up the in-place air/ground communication system.

b. System Description. Air/ground communications are provided by a network of radio transmitters and receivers located in such a way that line-of-site communications can be maintained with aircraft at specified altitudes and over specified geographical areas.

c. System Goal. The system goal is to provide communication between controllers and any aircraft in controlled airspace with as near to 100% reliability as is economically feasible.

d. Criteria for Implementation. Air/ground facilities are established, changed, or modified on a case-by-case basis in a continuing effort to provide radio coverage to meet changes in air traffic flow and to increase the system reliability.

e. Bibliography.

(1) Federal Aviation Administration, FACILITY OPERATION, FAA Handbook 7230.1, April 1, 1967, Washington, D. C.

(2) Federal Aviation Administration, PROVISION, USE, AND FREQUENCY ASSIGNMENT OF VHF AND UHF AIR-GROUND COMMUNICATIONS BY AIR TRAFFIC CONTROL FACILITIES, Agency Order 7031.1, Washington, D. C.

(3) Federal Aviation Administration, AIRWAYS PLANNING STANDARD NO. 2, AIR ROUTE TRAFFIC CONTROL, FAA Handbook 7031.3, Washington, D. C., July 2, 1965, 14 pp.

4. Flight Service Station Air/Ground Communication In-service Improvements.

a. System Requirement. There is a requirement for the exchange of in-flight reports, advisories, and other communications essential to the safe and efficient conduct of flight operations in addition to those requirements for traffic control purposes.

b. System Description. The air/ground communication system is composed of approximately 1800 radio transmitters and receivers located at 391 flight service stations, and at 5[illegible]9 associated remote communication outlets.

c. System Goal. The goal of the flight service station air/ground communication system is to provide reliable communications between the station and aircraft.

d. Criteria for Implementation. Flight service stations and remote communications outlets are established, changed, or modified on a case-by-case basis in a continuing effort to provide adequate service to the flying public.

e. Bibliography. None.

CHAPTER 2. VOICE COMMUNICATIONS

1. Electronic Voice Switching System.

   a. System Requirement. With the forecast increase in air traffic, the increased communication burden placed upon the air traffic controller must be as small as modern technology permits to maintain current standards of safety. With the continuing implementation of automation in air traffic control, there is a requirement that the communication system provide equivalent flexibility and reliability equivalent to that provided in the automated air traffic control system.

   b. System Description. There is no approved agency system which meets this total requirement.

   c. System Goal. The system design and organization must minimize the controller's effort and attention devoted to communication and will be designed for high reliability and operational flexibility.

   d. Criteria for Implementation. The EVS system will be implemented in all ARTCCs and most TRACONs when development is completed.

   e. Bibliography.

(1) Federal Aviation Administration, OPERATIONAL REQUIREMENTS FOR NAS STAGE A ENROUTE, Appendix III, revised February 21, 1966, Washington, D. C.

(2) Federal Aviation Administration, PROVIDE A VOICE COMMUNICATIONS SYSTEM (RADIO AND INTERPHONE) FOR NAS STAGE A ENROUTE CENTERS, FAAR 7320.1, Washington, D. C., June 6, 1966

2. FSS Communication Switching System.

   a. System Requirement. Projections of the population of the General Aviation Fleet including long-range jet business aircraft and air taxi aircraft indicate that the present communication switching system will have to be expanded. Since the present system is technologically obsolete, there is a requirement to provide a new system for the expansion.

   b. System Description. There is no agency approved system that will meet the system requirement.

c. System Goal. The goal of this effort is to increase the operational effectiveness and cost effectiveness of FSS communications by the application of modern technology and system engineering.

d. Criteria for Implementation. Not yet developed.

e. Bibliography. None.

3. Voice Recorders.

a. System Requirement. In order to maintain accurate records for the purpose of the investigation of accidents and malfunctions of the air traffic control system, each facility records all air traffic control voice communications that are transmitted by electrical means. In the event of a recorder channel failure at a position, operational procedures require that the controller keep a written log of all ATC clearances. Each controller must be provided with a discrete recorder channel. In view of the fact that the air traffic control facilities are expanding at a rapid rate and that the present recorders are technologically obsolete and expensive to maintain, there is a requirement to provide more efficient voice recorders for ATC facilities.

b. System Description. Recorders of two capacities are planned for implementation during the next 10 years. One is a five-channel cartridge recorder which can record 24 hours without a tape change. This agency approved recorder is intended for ATCTs and FSSs. The other is a high capacity recorder which is intended for use in facilities requiring over 20 channels. There is no agency approved system to meet the latter requirement.

c. System Goal. The goal of the present recorder program is to reduce the overall cost of recording when considering equipment cost, installation, maintenance, logistics, and tape handling over a 15-year life period.

d. Criteria for Implementation. One recorder channel is provided for each ATC position in a facility. One channel of each recording tape is reserved to record time. Each facility is provided with a playback unit.

e. Bibliography.

(1) Federal Aviation Administration, FACILITY OPERATION, FAA Handbook 7230.1, Washington, D. C., April 1, 1967

4. Voice Communications Switching In-service Improvements.

a. System Requirement. To meet the increasing demand for voice communications switching caused by the increase in air traffic, it is necessary to modify, expand, and rearrange equipments that make up the in-place voice communication switching system.

b. System Description. The present system consists of a radio channel section subsystem, an RCAG control subsystem, a recorder channel mixing subsystem, a maintenance communication subsystem, an intercom subsystem, and an interphone subsystem. The latter two subsystems are combined and leased from common carriers.

c. System Goal. The goal of this effort is to continue the current system with minor improvement, to maintain or increase its operational effectiveness as operational requirements change, and to expand the system capacity as requirements increase.

d. Criteria for Implementation. Implementation is determined by a case-by-case study.

e. Bibliography. None.

CHAPTER 3. DATA COMMUNICATIONS

1. Data Transmission Systems.

a. System Requirement. The basic design of the National Airspace System is predicated on providing to the aviation community automated air traffic control services from take-off to landing at all ATC facilities, terminal and enroute, where automation is warranted. The present policy for automation of ATC services requires all such facilities be interconnected with medium-or-high-speed data transmission links. Timely development activities are required to provide hardware for implementation with programs planned for enroute and terminal.

b. System Description. There is no agency approved system that will meet the total system requirement.

c. System Goal. Firm operational requirements have not been defined for narrow-band digital data transmission to be implemented between terminal radar (ASR) sites and the associated automated TRACON facilities located at airports in high activity terminal areas. Preliminary studies and analysis indicate, however, a data transmission rate of at least 20,000 BPS will be required. Tests will be conducted to determine maximum data rate achievable over voice bandwidth channel with present state-of-the-art modems that will meet our reliability requirements. The same techniques will also be applicable for certain enroute facilities which will require a higher data transfer rate at a later date.

d. Criteria for Implementation. This system will be utilized where the required data rate to be transmitted exceeds that provided by current systems.

e. Bibliography.

(1) Federal Aviation Agency, PRINCIPLE OF DIGITIZING AND NARROW BAND REMOTING OF RADAR AND RADAR BEACON INFORMATION, Washington, D.C., September 2, 1964

(2) Federal Aviation Administration, SYSTEM DESCRIPTION, NAS ENROUTE STAGE A, Communication Subsystem, Section 3.7, Washington, D.C., May 30, 1968

(3) Federal Aviation Administration Specification FAA-TD/S-120-801 dated December 15, 1967, System Technical Description and Specification for Modularly Expandable ARTS III Beacon Tracking Level Systems; Data Acquisition Subsystem - Remote Configuration, Section 3.7.1.2

(4) System Description, National Airspace System, En Route Stage A dated May 30, 1968; Communications Subsystem, Section 3.7

2. Low Cost Broadband Radar Remoting System.

a. System Requirement. There is a requirement to remote scan-converted terminal radar data via closed circuit TV to high activity non-radar equipped control towers and to remote terminal radar data to consolidated TRACON facilities.

b. System Description. There is no agency approved system that will meet the system requirement.

c. System Goal. The system goal is to provide a 15 GHz microwave system to remote BRITE I scan converted radar data and solid-state radar multiplex equipment for use with foregoing RF equipment for short haul raw radar remoting (RML) applications. Studies of alternative methods have been made and these methods have been rejected in favor of the microwave system.

d. Criteria for Implementation. The criteria established for TV, ASR remoting to non-radar equipped airport control tower cabs are: adequate radar coverage from a nearby, 20 mile or less, ASR installation and a minimum of 35,000 aircraft operations per year.

e. Bibliography.

(1) Federal Aviation Administration, PROVIDE LOW COST SURVEILLANCE RADAR REMOTING EQUIPMENT, Washington, D. C., March 31, 1967

3. Service B Data Interchange System.

a. System Requirement. The FAA is required to exchange a variety of messages among the various Air Route Traffic Control Centers, Flight Service Stations and related administrative offices. These messages deal with aircraft movement, control and safety on a national and international basis; support messages for general aviation; radiological hazard notifications; pilot weather reports; law enforcement messages; broadcast text of aviation forecasts; certain aviation weather reports; certain national defense messages; mechanical reliability reports; NASCOM reports; emergency airworthiness messages and administrative messages. The FAA also has been charged by the National Communications System to deliver emergency messages originated by the Office of the President. These messages must be handled

in a timely manner. In some cases, the requirement is that the message has to go from the point of origin to the destination in a few seconds, even in peak traffic periods.

b. System Description. There is no approved agency system which meets the total system requirement.

c. System Goal. The system goal is to replace the present electromechanical, wired logic message distribution system with a programmable electronic digital computer message distribution system which has the capability of meeting the system requirement and which has the capability of future growth. Because the present system is already overloaded and rapidly becoming more unacceptable, the goal is to implement the new system as soon as possible.

d. Criteria for Implementation. Only one system is required for the continental United States.

e. Bibliography.

(1) ICAO, MANUAL ON PLANNING AND ENGINEERING OF AERONAUTICAL FIXED TELECOMMUNICATION NETWORK, Document 8259-Com/553/3

(2) Federal Aviation Administration, SERVICE B INTERCHANGE SYSTEM, Order AT P 7330.1, Washington, D. C., July 1961

(3) Federal Aviation Administration, AERONAUTICAL COMMUNICATIONS AND PILOT SERVICES, Handbook 7300.7, Washington, D. C.

(4) Federal Aviation Administration, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Handbook 1000.1, Washington, D. C., May 3, 1965, p. vii and Attachment 1

4. Alaska Weather Communications System.

a. System Requirement. The FAA provides the aviation industry, the Weather Bureau and the military aviation services with rapid, high-volume distribution of weather data and Notices to Airmen in direct support of the safe and efficient movement of air traffic. Due to the highly perishable nature of weather data and analyzed weather products, the very minimum of transmission time should be involved.

b. System Description. There is no approved agency system which meets the total system requirement.

c. System Goal. The system goal is to replace the present electro-mechanical, torn tape message distribution system with a programmable electronic digital computer message distribution system which has the capability of meeting the system requirement and which has the capability of future growth. Because the present system is already over-loaded and rapidly becoming more unacceptable, the goal is to implement the new system as soon as possible.

d. Criteria for Implementation. Only one system is required for Alaska.

e. Bibliography.

(1) Federal Aviation Administration, MODERNIZED TELETYPEWRITER COMMUNICATIONS SYSTEM, Selection Order 1010.36, Washington, D. C., May 18, 1966

5. Data Communications In-service Improvements.

a. System Requirement. To meet the increasing demands for data communications caused by the increase in volume and speed of air traffic, it is necessary to modify, expand and rearrange equipments that make up the in-place system to increase its capacity, efficiency and speed.

b. System Description. The present data communications system consists of: (1) digital data transmission systems for the transfer of radar data to computers or video displays and the transfer of data between computers; (2) weather message communications systems; (3) aircraft movement message communications systems; and (4) related equipments.

c. System Goal. The goal of this effort is to continually update the current system with minor improvements to maintain or increase its operational effectiveness as operational requirements change, and to expand the system capacity as requirements increase.

d. Criteria for Implementation. Implementation is based on a case-by-case study of requirements.

e. Bibliography.

(1) Federal Aviation Administration, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Handbook 1000.1, Washington, D. C., May 3, 1965, Attachment 1

(2) Federal Aviation Agency, MODERNIZED WEATHER TELETYPEWRITER COMMUNICATIONS SYSTEM, Selection Order 1010.36, Washington, D. C., May 18, 1966

CHAPTER 4. FUTURE COMMUNICATIONS

1. Satellite Application.

   a. System Requirement. The Federal Aviation Administration, in order to contribute to International Civil Aviation Organization (ICAO) objectives, cooperates in the provision and planning of international air traffic service. Deficiencies in over-ocean air traffic communications are now recognized nationally and internationally to create operationally limiting conditions and to compound the problems of providing adequate air traffic services to the present and predicted air traffic.

   b. System Description. There is no agency-approved system to meet the system requirement. There is in existence, however, a U.S. Requirement and a U.S. National Plan outlining an evolutionary approach to an aeronautical satellite, starting with an early communication capability and eventually reaching a full-capability aeronautical satellite. The latter will be defined in the course of this evolutionary process.

   c. System Goal. A program to evaluate the use of artificial earth satellites that provide communications, position determination (surveillance) and possibly navigation is intended to demonstrate such potential as indicated by recent work in this field. This program is to provide development of future air traffic service coverage in oceanic-international airspace.

   d. Criteria for Implementation. Direct pilot-to-controller communications for aircraft operating in the oceanic flight information regions under United States jurisdiction, regardless of altitude or direction with a reliability of at least 99 percent is desired. International agreement must be reached regarding timing, frequency assignment, financing, method of provision, system configuration and operational procedures.

   e. Bibliography.

(1) Federal Aviation Administration, PROVIDE AIR-GROUND COMMUNICATIONS FOR TRANSOCEANIC AND SPARSELY POPULATED AREAS, FAAR 7310.2, Washington, D.C., July 31, 1967.

(2) Interagency Group on International Aviation, AERONAUTICAL TELECOMMUNICATIONS SERVICES VIA SATELLITES -- STATEMENT OF REQUIREMENTS FOR USE BY U.S. SPOKESMEN AT INTERNATIONAL MEETINGS, IGIA 77/1.29F, Washington, D.C., September 4, 1968.

(3) Interagency Group on International Aviation, AERONAUTICAL TELECOMMUNICATIONS SERVICES VIA SATELLITES -- NATIONAL PLAN FOR USE BY U.S. SPOKESMEN AT INTERNATIONAL MEETINGS, IGIA 77/1.31C, Washington, D.C., November 13, 1968.

2. Automatic Ground/Air/Ground Communications.

a. System Requirement. In order to maintain a safe and efficient air traffic control system there are requirements to reduce the pilot and the controller voice communication workload, to improve radio frequency utilization and to provide a wide variety of data in machine format to the data processing equipment of the automated NAS and related systems.

b. System Description. There is no agency approved system to meet the system requirement.

c. System Goal. The system goal is to automate the interchange of all routine information, and as much non-routine information as is practical, between aircraft and automated ground systems.

d. Criteria for Implementation. The program has not advanced to a stage which would permit firm criteria to be established. The existence of a reasonably well automated ground environment is essential; other criteria will be developed during the program.

e. Bibliography.

(1) Federal Aviation Administration, DESIGN FOR THE NATIONAL AIRSPACE UTILIZATION SYSTEM, Washington, D.C., June 30, 1969, 450 pp.

(2) International Civil Aviation Organization, AUTOMATIC DATA SYSTEMS, U.S. Position Paper on agenda item No. 1, COM/OPS Divisional Meeting 1966, Montreal, Canada.

CHAPTER 5. LEASED COMMUNICATIONS

1. Switching Systems

a. System Requirement. Switching systems are required to interconnect controllers in ARTCCs to controllers in ATCTs and FSSs and others who supply data to the air traffic control system.

b. System Description. Currently the Western Electric 300 System is agency approved for use in ARTCCs and the 301 system is approved for use in ATCTs. Other smaller systems are used in ATCTs and FSSs which are not formally agency approved but have been in service for many years. Those systems will continue in service until they become operationally or economically obsolete.

c. System Goal. The agency goal is to replace all 300 systems and some 301 systems with an Electronic Voice Switching System, to improve the system operational capability and reliability.

d. Criteria for Implementation. Ea ATC facility must be equipped with a voice switching system. The size of the facility determines which type of systems is provided. Unless it can be shown that Government ownership is more economical, these switching systems are leased.

e. Bibliography. None.

2. Circuit Expansion.

a. System Requirement. Virtually all air traffic control facilities are connected together by a network of lease circuits. The size of the network necessarily must increase as facilities are added and as the communications requirements at the facilities increase. This network must be as reliable as economically possible.

b. System Description. The goal of the agency is to provide as close to 100% reliability in the leased network as is possible by leasing redundant circuits and by the diverse routing of circuits.

c. System Goal. The system goal is to increase the reliability of leased circuits as the overall network is expanded to meet additional requirements.

d. Criteria for Implementation. Circuits are established, discontinued and rearranged as the result of case-by-case studies.

e. Bibliography. None.

BOOK 1
1/27/69

PART VI - AVIATION WEATHER AND OTHER SUPPORTING SERVICES

PART VI. AVIATION WEATHER AND OTHER SUPPORTING SERVICES

INTRODUCTION

This Part comprises miscellaneous services in support of the FAA mission. These services are either covered broadly in some of the preceding Parts or not covered at all. The services described in the following chapters of this Part are:

1. Aviation Weather
2. Aircraft and Equipment
3. Flight Information and Aeronautical Charting
4. NAFEC Facilities
5. Housing and Utilities at Isolated Locations

This Part discusses the system requirement, system description, system goal, criteria for implementation and bibliography associated with each service.

CHAPTER 1. AVIATION WEATHER

1. System Requirement. There is a need for an adequate system to disseminate and present the current and forecast weather information of the National Meteorological Service System to meet the requirements of the aviation community, particularly as related to information on operationally adverse weather.

2. System Description. The essence of the National Airspace System weather support for aviation is the timely availability of operationally useful weather information to all users. Those benefitting from this service include all pilots, operations offices, and the Air Traffic Control System. Weather information is often critical to pilots with respect to flight safety; however, in the operation of the NAS a broader concept is taken and weather factors are carefully considered for their effect on the total function of aircraft control. Key areas of consideration are the effects of weather on both terminal and enroute operations, flow control, and airport acceptance rates.

   Aviation weather services are both a part of the National Airspace System and a subsystem of the National Meteorological Service System (NMSS). The NMSS is the total Federal system (except the specialized military weather services) which furnishes meteorological services to the public and specialized user groups. The NMSS is composed of the Basic Meteorological System and the specialized weather services of which the Aviation Weather System is one. The Basic Meteorological System encompasses all activities required to produce or complete a description of the atmosphere in time and space and those activities required to derive the products needed by the whole population in their normal daily actions and for the protection of life and property. The Aviation Weather System is dependent upon the Basic Meteorological System for the main source of its intelligence, but supplements this primary data with additional observations and analyses needed for aviation purposes only. Activities of the system include these supplemental observations and their collection; terminal and enroute forecasts and warnings; and the dissemination, display and presentation of required weather information. The Aviation Weather System, then, is those weather services and facilities which are necessary to serve the total aviation community and which are peculiar to the interests of aviation.

   The activities of the Aviation Weather System given above are the responsibility of the FAA, except for production of the forecasts. Other important weather roles of the FAA are to coordinate planning of the weather service to meet aviation needs and the establishment of aviation requirements to which the National Meteorological System must respond. The FAA and Weather Bureau also act as agents in the

other's area of responsibility where advantageous to the Government. Examples in the operations area are the FAA's taking of basic weather observations and the Weather Bureau's briefing of pilots on weather matters. Similarly, examples exist in the R&D area where, for instance, the FAA provides funding and management direction for improving aviation weather forecasts.

3. System Goal. The FAA goal for the Aviation Weather System is to:

a. Ensure the availability of required weather information to the aviation community and to assist in its optimum utilization;

b. Improve the level of pilot education and training with respect to the understanding and use of weather data;

c. Ensure development and encourage application of operational weather modification;

d. Foster understanding of the environment for application in aircraft design and certification.

4. Criteria for Implementation. Criteria for establishment and provision of most aviation weather subsystem elements in support of NAS are embodied in portions of the chapters on air traffic control, navigation and communications. The FAA intends to provide planning standards and system specifications in weather modification (R&D) subsequent to successful development and tests. Airport managers and airspace users will establish implementation criteria on a local basis.

5. Bibliography.

a. U.S. Congress, THE FEDERAL AVIATION ACT OF 1958, Public Law 85-726, 85th Congress S 3880, Washington, D. C., August 23, 1958, Section 101.(8), Section 307.(b), Section 310., and Section 312.(a).

b. Federal Aviation Agency, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Agency Order 1000.1, Washington, D. C., May 6, 1965, Chapters 2-5.

c. Bureau of the Budget, Executive Office of the President, POLICIES AND PROCEDURES FOR THE COORDINATION OF FEDERAL METEOROLOGICAL SERVICES, Circular No. A-62 to the Heads of Executive Departments and Establishments, Washington, D. C., November 13, 1963, 5 pp.

d. Federal Aviation Agency, MEMORANDUM OF AGREEMENT BETWEEN THE FEDERAL AVIATION AGENCY (FAA) AND THE ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION (ESSA) FOR THE ESTABLISHMENT OF WORKING ARRANGEMENTS FOR PROVIDING AVIATION WEATHER SERVICE AND METEOROLOGICAL COMMUNICATIONS, Agency Order 7000.2, Washington, D. C., September 2, 1965, [illegible] pp.

e. Federal Aviation Administration, FINAL REPORT OF THE AVIATION WEATHER REVIEW GROUP (AWRG), FAA, Washington, D. C., July 25, 1967, 43 pp. ALSO NOTE REFERENCES, pages 41-43.

f. Department of Commerce, Environmental Science Services Administration, Office of Federal Coordinator for Meteorological Services and Supporting Research, PLANNING GUIDELINES FOR A FEDERAL AVIATION METEOROLOGICAL SERVICE, Washington, D. C., August 1968, 57 pp.

CHAPTER 2. AIRCRAFT AND EQUIPMENT

1. System Requirement. The FAA needs aircraft and related equipment, including simulators and trainers, in association with:

   a. Programs on flight inspection of air navigation aids.

   b. Training of air carrier and general operation inspectors.

   c. Programs for aviation research and development.

   d. Logistic support plus job performance and proficiency flying.

   The aircraft fleet and ancillary equipment must be a mix of modern high-performance aircraft containing avionics with the required accuracy for adequate inspection of facilities. Our inspectors must be trained in modern aircraft equipped with new instrumentation systems to insure a quality of inspection that will assure competent airman and airworthy equipment in the National Airspace System. The use of simulators and trainers is practical economy in the total training program. The operating characteristics of the R&D fleet must be sufficiently varied to serve as a platform for various FAA R&D programs. To provide logistic support and meet job performance and proficiency flying requirements, we need the latest operational state-of-the-art equipment.

2. System Description.

   a. Flight Inspection. Agency aircraft and equipment are utilized to perform facility flight inspection in accordance with established requirements. Checks of the electromagnetic space radiation pattern of a facility must be conducted to determine qualitatively the degree of accuracy of the information presented and to assure continued accurate operation of the facility. This involves work associated with commissioning and periodic flight inspections of navaids to determine whether facility performance continues to meet criteria outlined in U. S. Standard Flight Inspection Manual; such effort is devoted to insure safety and practicability of authorized flight procedures for airways, routes and fixes, instrument approach procedures, terminal arrival and departure routes, holding patterns and obstruction evaluations.

      The flight inspection fleet is a mix of various aircraft utilized for the broad purpose of insuring safe and efficient use of the airspace and to foster civil aeronautics and air commerce. Some aircraft are used in inspections of navaids at lower or basic altitudes, while others are used to collect mass data on the accuracy of the VORTAC structure at intermediate altitudes ([illegible]), and to inspect facility performance at high altitudes.

The flight inspection fleet is equipped with airborne receivers, recorders and other electronic measuring equipment, though certain tasks are performed manually. As more modern ground facilities are installed, system improvements will be made to assure an accuracy in the evaluation equipment compatible with the accuracy of the nav-aids. As workload increases, the system will tend towards greater automation.

On-board avionics and communications equipment will be kept current as dictated by safety, reliability and cost savings.

Maintenance facilities are provided for the aircraft and airborne equipment. The program provides for the necessary hangar, line and shop equipment for efficient maintenance of each aircraft and associated avionic systems.

The Signal Evaluation Airborne Laboratory (SEAL) System is a precision system designed to make comprehensive, fast and accurate in-flight measurements of the performance of air navigation facilities located in the contiguous 48 states during day/night all-weather operations. The system will be installed in turboprop aircraft and will provide analog and digital data for in-flight and post-flight analysis. Precise space-point positioning will permit greater utilization of aircraft as well as increased accuracy of measurement. It will give the FAA an effective tool for flight inspection purposes in the heavily congested air traffic areas.

b. Training Aircraft. Agency aircraft and equipment are utilized for flight training programs designed to keep employees abreast of technological developments in aircraft, associated equipment and systems. This applies particularly to the training of air carrier operations and general inspectors on aircraft and equipment utilized by the public in those categories.

The training fleet is a combination of owned and leased aircraft, comprising a cross-section of state-of-the art operational aircraft. Where necessary, out-of-service training is utilized. This fleet is kept current by augmentation of newer aircraft as they become available. In addition, obsolete aircraft are removed from this fleet.

This program provides for training by flight simulators and variable stability trainers which simulate modern jet aircraft performance characteristics. Such equipment will be modernized, when required, to provide a capability similar to that used by the major airlines.

The newest instrumentation, electronic and guidance devices are utilized in our training programs in order to assure that the highest degree of safety is maintained, as well as to acquaint our inspectors with the latest avionics.

c. Research and Development Aircraft. In the interests of maintaining a safe and highly efficient aviation environment and in support of FAA missions to insure safe and efficient utilization of the national airspace by military and civil users and to foster civil aeronautics and air commerce, the FAA's Systems Research and Development Service is actively engaged in various projects designed to support aircraft systems modernization such as "Approach and Landing Systems," airborne systems Categories II and III operations and others in the navigation, Air Traffic Control and communications areas that necessitate the use of efficient modern test-bed aircraft for research application. When the aircraft assigned to R&D do not possess the operating characteristics necessary for the projected requirements, new aircraft are procured and equipped for the tasks.

d. Logistics, Job Performance, Other. This program provides the modern turboprop and turbine-powered aircraft needed for proper logistics, proficiency flying and program support. It also provides for updating the avionics as significant advances occur

3. System Goals. Two goals apply to the flight inspection program:

a. In accord with aircraft implementation criteria, replace aging aircraft with modern high performance types to increase productivity and efficiency and reduce flight inspection costs.

b. Introduce avionic systems possessing the latest state-of-the-art improvements with accuracies compatible with equipment and facilities being introduced.

Two goals apply to the training program:

a. Maintain a staff of inspectors adequately trained in aircraft utilized by aviation activities in order to serve the public as empowered through statute responsibility under established public laws.

b. Utilize systems and equipment possessing the latest state-of-the-art improvements in order to keep abreast of technological developments.

It is the goal of the agency to provide suitable aircraft for support of research and development efforts in accord with implementation criteria.

The FAA has a goal to supply aircraft necessary for logistic support at remote locations and for job performance and proficiency flying in accord with implementation criteria.

4. Criteria for Implementation. The changes in the aircraft fleet and associated avionics, for each phase of the program, are based on operating efficiency and/or economy, demonstrated by analysis. Similar criteria are applicable to simulators. To assure reliable operation within established standards, changes in aircraft and avionics must be reviewed for impact on hangar, line, and shop equipment as maintenance facilities must be compatible with the fleet and avionic systems.

5. Bibliography.

a. Federal Aviation Agency, FAA ORGANIZATION HANDBOOK, Agency Order OA P 1100.1, Policies and Standards, Chapter 3, Section 1, Paragraphs 22a, b, c, Washington, D. C., December 23, 1966.

b. Federal Aviation Agency, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Agency Order 1000.1, Chapters 2, 3, 5, Washington, D. C., May 6, 1965.

c. Department of Transportation, Federal Aviation Administration, FLIGHT STANDARDS ORGANIZATION HANDBOOK, Chapter 3, Paragraph 19a (7 and 8) c and d, Washington, D. C., June 4, 1968.

d. Federal Aviation Agency, U. S. STANDARD FLIGHT INSPECTION MANUAL, Agency Order OA P 8200.1, Section 100, Washington, D. C., May 1963.

e. Federal Aviation Agency, ACQUISITION OF AIRCRAFT FOR AGENCY USE, Agency Order OA P 4400.1, Paragraph 2, Washington, D. C., March 19, 1963.

f. Federal Aviation Agency, CRITERIA FOR ASSIGNMENT OF AGENCY AIRCRAFT, Agency Order OA 4040.4, Washington, D. C., February 1, 1965.

g. Federal Aviation Agency, NEW BASIC FLIGHT INSPECTION SYSTEM, March 1965; Prepared by Airborne Instruments Laboratory. 78 pp. and appendices.

h. Federal Aviation Agency, VOR/LOCALIZER FLIGHT INSPECTION RECEIVER, January 1967; Prepared by Airborne Instruments Laboratory. 62 pp.

i. Federal Aviation Agency, SEAL CONTROL, DISPLAY AND RECORDING CONSOLE, October 1967; Prepared by Airborne Instruments Laboratory. 112 pp.

j. Federal Aviation Agency, ILS FLIGHT INSPECTION POSITIONING SYSTEM, July 1968; Prepared by Westinghouse Defense and Space Center. 96 pp.

k. Federal Aviation Agency, ILS FLIGHT INSPECTION POSITIONING SYSTEM TEST AND EVALUATION, September 1968; Prepared by National Aviation Facilities Experimental Center. 33 pp. and appendices.

CHAPTER 3. CHARTS AND FLIGHT INFORMATION

1. <u>System Requirements</u>. The system requirements for aeronautical charting and flight information services originate in the sections of the Federal Aviation Act of 1958 that deal with: Fostering air commerce (Sec. 305); National defense and civil needs (Sec. 306); Airspace control and facilities (Sec. 307); Collection and dissemination of information (Sec. 311); Development planning (Sec. 312). Of particular significance is the specific reference in Section 307(b)(3) which authorizes the Administrator to arrange for publication of aeronautical maps and charts required for the safe and efficient movement of aircraft in air navigation, making use of the facilities and assistance of existing agencies of the Federal Government to the extent practicable.

2. <u>System Description</u>. The concept referred to in Section 307 above is the one presently employed by the FAA to satisfy aeronautical information requirements. Information is collected from and distributed through appropriate agencies of the government in the form of charts, information manuals and notices as the most effective method of satisfying system information requirements. Aeronautical charts and flight information translate into useful form the rules, regulations, hazards, aviation facility status, topography, instructions and other operational factors affecting visual and instrument flying. To implement these charting and information services the FAA has established its National Aeronautical Charting Program, and maintains an in-house flight information publications program. Under the National Aeronautical Charting Program, the Coast and Geodetic Survey (C&GS) acts as the producer for most of the required charts. Many of these charts consist of entire series--low altitude, high altitude, sectional, instrument approach, etc. The airport obstruction charts, based on a special mapping and surveying program operated by FAA and executed by C&GS, are a special subprogram.

   In addition to the aeronautical charts, flight information publications also provide a support service to aviation. FAA's flight information publication program includes items such as the Airman's Flight Information Manual, Flight Data Digest, and a series of agency handbooks, providing the specific operating instructions to air traffic personnel.

   As new facilities and procedures are introduced in the air traffic system, and new cartographic or reproduction techniques are developed, the charts and publications require updating. New charts and publications are developed, tested and put into effect. A continuing reassessment is made to assure that these products provide the flight information that is needed for safety in the airspace.

All Federal Government charts and publications used by the aviation public are obtained through purchase from the C&GS or the Government Printing Office (GPO). The FAA funds for such special items as controller charts and the airport obstruction survey program. Additionally, the FAA reimburses the C&GS and the GPO for those charts and publications which the agency needs for internal uses.

When changes occur in facilities, flight rules, or procedures that are time critical, they are disseminated quickly to the areas of prime concern by the National Notice to Airmen (NOTAM) System which has been developed to keep this basic information current.

NOTAMs and Airmen Advisories (AIRADs) are the two kinds of notices prepared for airmen and disseminated by the National Notice to Airmen System. Essentially, the difference between these notices is that a NOTAM requires expeditious dissemination by telecommunications means and an AIRAD normally is given only local dissemination during the pre-flight or in-flight briefing or during other contact with pilots. Both contain essential information on the status of components of the air traffic system.

NOTAMs are transmitted over a teletypewriter network which also collects and distributes aviation weather. The capacity of this network, especially the circuit time for NOTAM transmission, places limitations on the dissemination of NOTAMs. It is important, therefore, that the data transmitted be only the essential information which would influence a pilot's decision to go or not to go on a planned flight, or to abort or to change a flight already in progress. In the operation of its Notice to Airmen System, FAA has been able to automate some operations with encouraging results. By use of a computer, NOTAMs issued over the past 24 hours throughout the conterminous U. S. are summarized as a NOSUM and transmitted to FSS's and other users having need for these time critical elements of operational data.

The FAA's central source of operational information on the air traffic system is the National Flight Data Center (NFDC). The NFDC presently collects, validates, stores, and disseminates a vast amount of operational data furnished by and used by all elements of the agency. It provides aeronautical data for use of charting and publication entities of FAA, government and industry. It assures that the data provided is both uniform in content and that it comes from a single source, thereby eliminating conflicting and dangerous disparity which existed in the past. The NFDC is currently automating its data base, and through its computer-generated printouts will expedite and centralize the provision of hard-core operational data for a broad cross-section of agency users, as well as to other users in government and industry. Once the data central is fully automated, management, administrative, legal, and

similar peripheral data can be "grafted" into (but without prejudice to) the operational flight data base, and thus be capable of serving broader uses. The National Flight Data Center is currently located in the headquarters building in Washington, D.C.

3. System Goal. The goal is to: ensure the provision of appropriate aeronautical charting and flight information services required for safe and efficient navigation in the airspace; and to establish and maintain in the FAA a secure facility, utilizing sophisticated electronic equipment and techniques.

4. Criteria for Implementation. The FAA Flight Information Program (Agency Order 1100.86, dated 4/12/65) prescribes the objectives, responsibilities, procedures, and provides the concepts and direction for the dissemination of aeronautical and flight information.

Agency Order 7930, National Notice to Airmen System, establishes criteria and responsibilities for preparing and disseminating NOTAMs. Instructions to FAA field installations as to what information is reportable by NOTAM or AIRAD is contained in Agency Handbook 7300.7, Aeronautical Communications and Pilot Services. Information on material for publication in the Airman's Information Manual is contained in Agency Order 7920.1, Content Criteria for Airman's Information Manual.

5. Bibliography.

a. U.S. Congress, THE FEDERAL AVIATION ACT OF 1958, Public Law 85-726, Washington, D.C., August 23, 1958, as amended (49 U.S.C. 1301-1541).

b. Federal Aviation Agency, AGENCY FLIGHT INFORMATION PROGRAM, Agency Order OA 1100.86, Washington, D.C., April 12, 1965.

c. Federal Aviation Agency, ESTABLISHMENT OF FAA CARTOGRAPHIC REQUIREMENTS GROUP, Agency Order AD 1110.2, Washington, D. C., December 3, 1963.

d. Federal Aviation Agency, NATIONAL NOTICE TO AIRMEN SYSTEM, Agency Order OA 7930.1, Washington, D. C., December 8, 1964.

e. Federal Aviation Agency, POLICY STATEMENT OF THE FEDERAL AVIATION AGENCY, Washington, D. C., April 1965, xiv and 87 pp. and charts, p. xiii, item 43.

f. Federal Aviation Agency, AERONAUTICAL COMMUNICATIONS AND PILOT SERVICES, Agency Order OA 7300.7, Washington, D. C., March 1966.

g. Federal Aviation Agency, CONTENT CRITERIA FOR AIRMAN'S INFORMATION MANUAL, Agency Order OA 7920.1, Washington, D. C., November 1, 1965, 5 pp.

CHAPTER 4. NAFEC FACILITIES

1. System Requirement. As part of its R&D cycle, the FAA must conduct test, experimentation and evaluation efforts aimed at improving the aviation system. Many of these major efforts are best performed at a centralized set of facilties at an airport.

2. System Description. The National Aviation Facilities Experimental Center (NAFEC) was established as the site of an experimental research and development center. The location in southeastern New Jersey was chosen for a variety of reasons: the site, a former Naval Air Station, provides a low-activity airport with a surrounding complex of buildings sufficiently removed from the population centers which could be disturbed by the efforts; yet it is sufficiently close to the high density air traffic areas of New York, Philadelphia and Washington and several high-activity airways. The original complex of wooden buildings was constructed by the Navy in 1942, with a planned life of ten years.

The National Aviation Facilities Experimental Center (NAFEC) employs a staff of aviation specialists, technicians and engineers responsible for testing, experimentation and evaluation to improve the air traffic system. The facilities at the center include: (1) range instruments such as MSQ radar, MOPTAR and TAIR; (2) simulation equipment for aircraft flight and air traffic control; (3) surveillance radars; (4) navigation aids; (5) communications subsystems; (6) an air traffic control system laboratory; (7) a variety of R&D service facilities; (8) aircraft safety equipment such as drop test, air gun and catapult; (9) FAA aircraft; (10) airport equipment--for example, experimental runway lighting; and (11) computation and data processing equipment. These facilities are used by the FAA in accomplishing its own mission; and are also available for the use of other governmental agencies and industry.

3. System Goal. The objectives of reconstruction, maintenance and improvements to this centralized facility are reduced operating costs and increased efficiency of the test environment consistent with the needs for expansion of our technological capabilities. The major reconstruction efforts are to be completed during the early phases of the plan in accordance with the criteria.

4. Criteria for Implementation. The wooden buildings have exceeded their planned life and require excessive maintenance. Reconstruction and facility improvements should continue in accordance with an FAA plan approved in April 1963 to reduce the operating costs and increase the efficiency of the test environment. Our facility changes and additions are a result of individual administrative review.

5. Bibliography.

a. Section 312(c) FA ACT OF 1958.

b. FAA Handbook, SRDS TECHNICAL FACILITIES AT NAFEC, June 1963 (revised April 1965).

c. FACILITIES IMPROVEMENT PROGRAM AT NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER, Atlantic City, New Jersey, September 1965 (embodies 1963 facility improvement plan).

CHAPTER 5. HOUSING AND UTILITIES AT ISOLATED LOCATIONS

1. System Requirement. Housing and utilities are often substandard or non-existent in certain remote and isolated locations. This problem can be a source of employee discontent. The FAA needs programs to attract and hold employees at such locations, as a reduction in the turnover of employees leads to greater efficiency and economy.

2. System Description. This program provides for construction, maintenance and replacement of housing, utilities and certain support facilities at isolated locations where these are unavailable or substandard. The facilities provided differ from location to location, depending upon local needs. Locations served include Alaska, Pacific and Caribbean Islands, plus remote locations in the western United States.

3. System Goal. The government will provide housing and utilities to attract and hold employees in remote locations when administrative review indicates that adequate housing and utilities are not available through existing market mechanisms.

4. Criteria for Implementation. Decisions are based on a case-by-case administrative review.

5. Bibliography.

a. U. S. Congress, THE FEDERAL AVIATION ACT OF 1958, Public Law 85-726, 85th Congress S 3820, Washington, D. C., August 23, 1958, as amended (49 U.S.C. 1301-1541), Section 312(c).

b. Federal Aviation Agency, SRDS TECHNICAL FACILITIES AT NAFEC, Technical Facilities Manual, Order RD P 6000.2, Altantic City, New Jersey, December 1963, revised April 1965, 12 volumes.

c. Federal Aviation Agency, FACILITIES IMPROVEMENT PROGRAM AT NATIONAL AVIATION FACILITIES CENTER ATLANTIC CITY, N. J., SEPTEMBER 1965 (revision and extension to 1963 facility improvement plan).

BOOK 1
1/27/69

PART VII - AIRPORTS

NOTE

The previous parts of this book relate primarily to that segment of the National Aviation System which is established, operated, and maintained by the Federal Government. As such, it is possible to discuss in detail the requirements, systems descriptions, goals, and criteria as the decision making function falls exclusively within Federal domain.

While the airport is an integral part of the system, the Federal role is significantly different. The following part has been structured in similar fashion but does not address itself to some of ' major problems that exist within the system nor does it clearly define the future courses of action which will result from further delineation of the Federal role in airport systems planning, standards, and development.

Instead, the Chapter relates the history and current FAA involvement in airport systems development. If new legislation is enacted, or existing authorities extended, a re-appraisal of the Federal role will be required. Such re-appraisal will be the subject of future industry conferences.

Regardless of the future direction, however, the need will continue to exist for an integration of airways and airports development. Issues of airport location in relationship to airways capacity, the competition of geographical or political jurisdictions for the air passenger, the acceptability of an airport as a neighbor, etc., will still require the development of a body of Federal policies and goals. These will be forthcoming as better definition of the Federal involvement is obtained.

PART VII. AIRPORTS

INTRODUCTION

The airport is a vital element of the National Aviation System and is recognized as one of the controlling factors in the achievement of maximum system capacity. The interrelationship between the airport and the air traffic control/navigation subsystems in terms of achieving maximum capacity is such that balanced airport development and electronic equipment implementation is essential. Unlike the air traffic control, navigation, communications, weather, and data acquisition subsystems which are the responsibility of the Federal Government to install, operate, and maintain, the airport is the responsibility of local authorities. The role of the Federal Government in the airport picture is, therefore, primarily one of determining the Nation's airport requirements, encouraging development, establishing airport standards, and assuring adherence thereto in matters affecting both the safety and the efficiency of air traffic movement. This role is carried out within the authority contained in the Federal Aviation Act and the Federal Airport Act.

Under the Federal Aviation Act of 1958, the Federal Government is directed to make long range plans for and formulate policy with respect to the orderly development and location of landing areas as will best meet the needs of civil aeronautics, and which shall give full consideration to the requirements of national defense; and under the Federal Airport Act of 1946, to annually prepare a National Airport Plan (NAP) which specifies the development required to provide a system of public airports adequate to anticipate and meet the needs of civil aviation.

CHAPTER 1. AIRPORT SYSTEM PLANNING

1. System Description.

The need for a standardized system of civil airports was first recognized in 1939; however, concentrated Federal action to fulfill this need did not follow until enactment of the Federal Airport Act of 1946, and subsequently the Federal Aviation Act of 1958. As a result, the layouts of many of our older airfields are outdated and inefficient for handling today's air traffic. Airport development of the last decade has not kept pace with the rapid technological advances and growth in civil aviation.

The present intent of Federal airport system planning is to identify airport development eligible for Federal aid; to identify facilities needed to support Federal navigation systems; to identify future financing needs related to such development; and, to guide development of airport aircraft operations areas in mutual support of the total civil aviation system.

The National Airport Plan prepared annually by the FAA lists the airports and facilities which currently make up the national system, and identifies the communities where new facilities are needed for an expanded system. The Plan identifies the airfield area development required over the next five years with estimates of associated costs. The development requirements included in the Plan are limited to items eligible for Federal assistance under the Federal-aid Airports Program (FAAP).

Criteria for determining the airport locations which qualify for inclusion are presently based on the need for access to the national air transportation system and the national interest in satisfying this need. Such criteria assume that a national interest in an airport location is present when a requirement exists for scheduled airline passenger service; when there is a substantial degree of non-local aviation activity; and, when lack of surface transportation access makes air access mandatory. The entry criteria are further categorized into those applicable to locations served by the scheduled airlines and those applicable to locations limited to general aviation transportation functions.

Airport locations are examined on the basis of present and future aeronautical activity, or where an airport is non-existent, on the basis of forecast air transportation potential. Also, all qualified locations are examined before development to be certain that the surrounding airspace will be properly used.

The detailed planning guidance and criteria used by the FAA in the development of the national system of airports, and the technical advisory services available to the public are listed in the Bibliography section of this chapter.

The current planning effort has five identifiable limitations:

a. It observes only a five-year horizon and, thus, merely serves as a short range action plan.

b. Its scope is limited to airfield development directly relating to the operation of aircraft. It thus fails to identify development needed in the airport's terminal and other support subsystems which must occur simultaneously with airfield development if a viable airport is to result; and which, if not timely accomplished, can limit the efficient use of airspace. Omission of such development precludes a factual assessment of the total development requirements facing the Nation.

c. It fails to identify the relative aeronautical role and system essentiality of each included airport. Such knowledge is critical to guiding orderly development of the airport system.

d. Its scope is limited to a system of airports adequate to meet the needs of civil aviation. It thus fails, in part, to meet the economic objectives of state and local governments.

e. Present planning is basically a Federal effort. While the present National Airport Plan is extensively coordinated with the industry, and with state and local governments, positive inputs from and contributing actions by such bodies are lacking in several respects.

Some of the underlying factors which affect the timely development of an effective National System of Airports and which necessitate an expanded planning effort are:

a. With few exceptions, the primary responsibility for constructing, maintaining, and operating public airports rests with the local or state owner rather than with the Federal Government. Such ownership covers a wide range of government - state, municipal, county, singularly or in combination; specifically empowered authorities; and private owners. The Federal Airport Act of 1946 as amended authorizes the Federal Government to deal directly with the public agency involved. However, in major metropolitan areas, there is the need to plan and implement a complex of airports embracing a large number of political jurisdictions. Only in rare instances does a public agency exist which is empowered to cope with the multiplicity of separate political entities comprising the whole area. The need is also thwarted by the fact that a multiplicity of separate political entities

possesses independent authority to block development of an airport within their respective jurisdictions. As a result, a critical need for additional facilities in most metropolitan areas is not being met.

The FAA has a special fund in its airport program to improve airports serving general aviation in metropolitan areas which relieve congestion at the major airports in the area. Under this program a number of new airports have been built and many existing airports have been improved. But, no general aviation airport has been built in a major hub in the last five years by the public agency owning and operating the major airport, with one exception. It is clear therefore that the existing political structure at the local level is unable to deal with the development of a system of general aviation airports in metropolitan areas.

b. Related to long-range land use planning is the need for new airports to be sited initially upon larger land areas than heretofore required, to ensure their future expansion capability. Also, there is the growing need for major communities to acquire, or otherwise reserve, lands for additional airports well in advance of the timing contemplated for their construction. When such needs are recognized, significant economic benefits accrue to the public in addition to the assured meeting of future aviation demands.

c. Recognition of an airport's ground access requirements -- present and future -- is also vital. The lack of adequate airport ground access systems not only constrains the aviation system, but often severely disrupts the community's transportation flow. This is demonstrated today at many major airports and the condition can be expected to occur at most of our large air transportation hubs during the next decade.

2. System Requirements.

Under existing law there is the requirement for the FAA to exercise leadership and, thus, to serve as the catalyst in planning for an adequate national system of airports. Within the framework of this broad requirement, there is a requirement for the agency to:

a. Promote, coordinate, and supplement the uniform accomplishment by others (including appropriate segments of the aviation industry) of long-range airport master planning, metropolitan-regional airport system planning, and state airport system planning; and integrate such planning into a short and long range plan guiding systematic development of an adequate national system of airports.

b. Take action to attain the continuing availability of an adequate network of airports by defining and continuously identifying the airport facilities needed to complement and support the safe and efficient use

of the Nation's airspace system. Both the national and local needs for airports will be considered in light of airspace usage and of both national and local economic objectives.

c. Take action to attain the continuing capacity adequacy of the airport's system by promulgating national and regional forecasts of civil aviation growth for the guidance of all civil airport planning agencies and by assisting such agencies in the translation of such forecasts into airport development needs and their impact upon a community's social and economic comprehensive planning actions.

d. Take action to attain individual airport and system operating safety and efficiency by providing technical advisory services to all civil airport planning agencies for all facets of airport development planning; including site selection and evaluation, layout and airport configuration, capacity analyses, airspace analyses, environmental compatibility analyses, and other similar technical services.

e. Seek to minimize the needs for public investment in new airport facilities by encouraging optimum civil-military joint use of existing federally owned facilities and through optimum development of single facilities to serve multiple geographic areas and the greatest population.

f. Take action to attain long term availability of all facilities determined essential to the civil system of airports by encouraging the public acquisition of those facilities which are privately owned and subject to diversion to other land uses.

g. Ensure continuing agency and public knowledge of the operational adequacy of existing civil airports by annually surveying their physical development, utilization, and operational limitations.

There is also a requirement for the agency to encourage and promote compatible land uses in the vicinity of airports. The airport should constitute a compatible element within the community served. This can only be achieved by effective action at the state and local levels of government. The agency will encourage intelligent and aggressive land use planning and zoning by state and local governments to assure that airports are available for the full range of aircraft operations required by an effective air transportation system.

Agency action with respect to airports in the form of regulation should be kept to a minimum necessary to meet national interests and responsibilities. These interests include assuring the availability of public

airports and promoting the safety of aircraft movements in and out of the Nation's airports. The airport is an integral part of an effective air transportation system, along with the aircraft and the airmen. Therefore, the location of airports so as to permit service to more than one community will continue to be encouraged where desirable in terms of the entire system. The exercise of leadership by the agency should not, however, obscure the fact that questions as to where airports are to be located, what their capacity and capability should be, what adjacent land uses should be, and what facilities and services should be provided on the airport must be answered to a major degree in terms of the desires and needs of the community.

3. System Goals.

National airport system planning and elemental development require timely, full, and reliable operational demand data, current and forecast, to intelligently plan and develop a responsive airport system. Long range aircraft development and procurement plans, the desires and needs of communities, as well as future route/service plans of the airlines, must be known and studied with sufficient lead time to plan for the orderly development of the airport facilities required. The FAA has established as its airport system planning program objectives:

a. The future existence at each appropriate level of government (national, state, and local) of uniformly developed, and continuously updated, long range development plans for each civil airport and each geographical subsystem of airports, which reflect optimum compatibility with the area's social and economic objectives as well as providing the development guidance needed to fulfill the area's long term aviation requirements.

b. The formulation and periodic revision of a long range National Airport Plan (at least a 10 year period) to guide systemwide airport development which:

(1) Reflects totally coordinated inputs and contributing actions from the aviation industry and throughout all levels of government.

(2) Identifies the airport facilities comprising both the existing and future needed civil airport system.

(3) Identifies the total scope and timing of development needed at each existing system airport to ensure their continued safe utilization and enhance their efficiency and capacity.

(4) Identifies the future facilities additionally needed by the system; including the timing of their need, their general location, the projected capacity demand, and their requirement for land reservation.

(5) Identifies current development costs of the needed civil system of airports, and the magnitude and timing of the system's future development needs.

c. The accomplishment of comprehensive regional-urban planning which considers the safety, efficiency, and future capacity requirements of civil aviation, and which:

(1) Ensures airport expansion capability.

(2) Reserves land areas for future aeronautical needs.

(3) Provides appropriate zoning of lands adjacent to and surrounding airports to compatible uses.

(4) Ensures adequate community/airport ground access.

The FAA's airport system planning processes and implementation criteria are currently in a state of transition. Various aspects of an expanded planning program designed to alleviate existing limitations are in the early stages of development or partial implementation. Primary agency plans for their accomplishment are outlined in Book II.

4. Bibliography.

a. Published Documents.

(1) U. S. Congress, The Federal Aviation Act of 1958, Public Law 85-726, Washington, D. C., August 23, 1958, as amended (49 U.S.C. 1301-1541) Sections 305, 312(a), 306, 308(b).

(2) U. S. Congress, The Federal Airport Act of 1946, Public Law 79-377, Washington, D. C., May 13, 1946 as amended (49 U.S.C 1101-1120) Sections 3(a,b&c) and 9(d)(1).

(3) Federal Aviation Agency, FAA Airports Planning Handbook, Agency Order 5090.1, Washington, D. C., November 27, 1965 and changes 1-12.

(4) Department of Transportation, Federal Aviation Administration (prior to 1968, Federal Aviation Agency) National Airport Plan, annual issue.

(5) Federal Aviation Administration (prior to April 1967, Federal Aviation Agency), pertinent Advisory Circulars are listed below by number, title, and date. 1/

AC 150/5050-1	Airport Planning as a Part of Comprehensive State Planning Programs (4-25-66)
AC 150/5050-2	Compatible Land Use Planning in the Vicinity of Airports (4-13-67)
AC 150/5060-1A	Airports Capacity Criteria Used in Preparing the National Airport Plan (7-8-68)
AC 150/5060-2	Airport Site Selection (7-19-67)
AC 150/5070-1	Rapid Transit Service for Metropolitan Airports (8-26-65)
AC 150/5070-2	Planning the Metropolitan Airport (9-17-65)
AC 150/5070-3	Planning the Airport Industrial Park (9-30-65)
AC 150/5070-4	Planning for Rapid Urbanization Around Major Metropolitan Airports (3-31-66)
AC 150/5090-1	Regional Air Carrier Airport Planning (2-2-67)

b. Advisory Circulars Pending Issuance/Completion.

AC 150/5060-3	Airport Capacity Criteria Used in Long Range Planning
AC 150/5310-2	Airport Planning and Airport Layout Plans (9-19-68)

1/ A brief description of each Advisory Circular (AC) is contained in the Advisory Circular checklist published periodically in the Federal Register (33 FR 14754-1477-10/2/68).

CHAPTER 2. AIRPORT STANDARDS

1. System Description.

National standards for civil airport development have existed almost since the Federal Government first had any concern in civil aviation. A few simple design standards were published around 1926 when aviation matters were centered in the Bureau of Lighthouses under the Department of Commerce. The succeeding years have seen these standards grow in number, detail, and scope. As growth and evolution have taken place in aircraft development, airport technical standards have been continually monitored and changed to provide for the demands of new aircraft.

In the mid 1940's legislation was passed (Federal Airport Act of 1946) to provide for Federal participation and assistance in the development of a National System of Airports. This assistance has had the effect of catalyzing local interest in securing a suitable airport for the community, as well as securing a system of airports supportive of national interests. The airport standards which have been produced since the Act's inception are in support of the Federal effort to provide a "system of public airports adequate to anticipate and meet the needs of civil aeronautics."

The cycle of developing a new and more demanding aircraft has generally been shorter than the time it takes to provide for a new airport. Consequently, many existing airports have been tailored and retailored to achieve a design capable of accommodating aircraft possessing characteristics very different from those for which the original airport was designed. Increases in volume of traffic has been the major obsolescing feature; and, in many areas, the ability to continue the retailoring process has almost reached its limit. On the whole, however, the airport built to established standards has had an acceptable longevity.

The lifetime usage of an airport is approximately twenty years plus, based on deterioration more than on technical obsolescence, and the large investment involved must be written off over this span of time. Significant changes in aircraft design, however, have been on a shorter time base. Transition from the DC-3 aircraft to DC-7 to B-377 in civil aviation occurred over a fairly short period (Post World War II - 1957). The B-707/DC-8 generation of aircraft doubled the weight of the preceeding B-377 and, over the past decade, have fixed the demand for design of major airports throughout the world. The middle-size jets (B-727/DC-9 generation) have set the pace for medium-range airport design over the past few years. Inauguration of B-747 operations within the next year

will impose much greater demands due to the increase in size, weight, and capacity of this aircraft over those currently being accommodated. Although general aviation aircraft had been relatively stable in regard to their airport needs, the entry of "business jets" has also changed this picture.

It has been agency policy to expand airport design standards to keep pace with the increasing demands of newly developed aircraft. However, there has already been some discussion that a time may be reached when the configuration and availability of existing airports could control the design of aircraft, much as the highway design has influenced the size of its using vehicle. Apparently, that point has not yet been reached. Thus on one hand, the Nation is faced with the problem of building new airports to support the more demanding aircraft; and on the other hand, the attendant problems of airport development competing for public funds and land against other community needs. Alternatively, redesign is attempted for airports which were built to standards for an older and less demanding generation of aircraft.

2. System Requirements.

The requirement to promulgate and publish standards for airport development stems from the legislative authority contained in Section 9(a) of the Federal Airport Act which states in part, "No project application shall propose airport development other than that included in the current revision of the National Airport Plan formulated by the Administrator, and all such proposed development shall be in accordance with standards established by the Administrator . . ." The agency prepares standards on airport development to provide for a high level of safety for the users of the system, as well as to promote the development of a system of airports which provides for optimum utilization of all components of the aviation system.

Within the framework of this broad requirement:

a. There is a requirement for the FAA to formulate and publish engineering and design, construction, and safety standards that will meet present needs of civil aviation and adequately anticipate its growth. The agency will provide guidance to airport authorities which establishes uniformity, adequacy, and longevity of airports serving various segments of the aviation industry. The agency must also maintain an expertise in allied areas to achieve compatibility with related requirements.

b. There is also a requirement that the agency, through international cooperation and active participation, will encourage the advancement and adoption of uniform design, construction, and ground safety standards in the International Civil Aviation Organization. The agency participates in the development of coordinated United States positions on the establishment or revision of international airport standards and criteria and on the establishment of requirements for airport facilities and services at international airports in the ICAO regions.

c. In implementing its requirement to foster the development of a safe and efficient national system of airports, the FAA will provide to the public the following technical advisory services:

(1) Safety standards and the techniques of their application for increasing safety of aircraft operations at civil airports, and for other safety features inherent in the design and construction of civil airports.

(2) Configuration and capacity standards to obtain a greater effectiveness of airport capacity in the movement and storage of aircraft and, concomitantly, to increase the capacity of surrounding airspace.

(3) Location and siting standards for effective siting of civil airports to ensure that the requirements of aviation safety, efficient utilization of airspace, load generating demands, and the interface with other transportation modes are met.

(4) Terminal facilities guidance for use in identifying problems in airport terminal facility design.

(5) Fire, crash, and rescue guidance for the survival of passengers and protection of property, and other aspects of safety effected by good operational practice.

3. <u>System Goals</u>.

The development and improvement of airport safety and design standards are essential for the orderly development of the Nation's landing areas. Future changes in aircraft performance and characteristics will have many different effects on the airport and system capacity. Therefore, it is vital that agency developed airport standards be periodically reviewed and updated in order to keep pace with the rapidly changing aviation technology. The FAA has established as its airport standards program

objectives the development and improvement of airport design and planning standards, including criteria on airport configuration and location, which will:

a. Provide a safe airport ground environment for the take-off, landing, and taxiing of aircraft in such terms as adequately designed, constructed and maintained runway and taxiway facilities, and existence of effective ground safety procedures, including fire, crash, and rescue services.

b. Foster the safety of flight in the immediate vicinity of airports by providing guidance for aircraft approach and departure paths adequately protected from natural or manmade ground obstructions.

c. Develop increased levels of airport safety through research resulting in development of special safety devices and techniques such as arresting gear, overrun and underrun areas, improved pavement braking action capabilities and terminal area weather control or modification.

d. Acquire the expertise and identify the constraints upon effective utilization of the national airspace imposed by terminal building area congestion. Determine what these constraints mean in terms of new runways, new airports, and off-airport terminal areas including V/STOL ports.

e. Develop improved guidance on optimum runway taxiway configuration to reduce runway occupancy time to the minimum practical value.

f. Determine the potential for augmenting airport system capacity by use of V/STOL airports.

4. Bibliography.

a. Published Documents.

(1) U. S. Congress, The Federal Aviation Act of 1958, Public Law 85-726, Washington, D. C., August 23, 1958, as amended (49 U.S.C. 1301-1541), Sections 311, 103(a), 306 and 307(b).

(2) U. S. Congress, The Federal Airport Act of 1946, Public Law 79-377, Washington, D.C., May 13, 1946, as amended (49 U.S.C. 1101-1120), Sections 9(a) and 9(d)(2).

(3) The Convention on International Civil Aviation, Chicago, 1944, Article 28(a)(61 Stat. 1188)

(4) Federal Aviation Agency, Objects Affective Navigable Airspace, Federal Aviation Regulations, FAR Part 77, Washington, D.C., May 1, 1965, (as amended by Code of Federal Regulations, January 1, 1968 edition).

(5) Federal Aviation Agency, pertinent Advisory Circulars are listed below by number, title and date of issuance

AC 150/1930-1	Radiological Decontamination of Civil Airports (8-19-66)
AC 150/4290-1	Assistance in Obtaining Copper Products for Airport Lighting (10-6-66)
AC 150/5200-1	Bird Hazards to Aviation (3-1-65)
AC 150/5200-2	Bird Strike/Incident Report Form (11-27-65)
AC 150/5200-3	Bird Hazards to Aircraft (10-7-66)
AC 150/5200-4	Foaming of Runways (12-21-66)
AC 150/5200-5	Consideration for the Improvement of Airport Safety (2-2-67)
AC 150/5200-6A	Security of Aircraft at Airports (6-28-68)
AC 150/5200-7	Safety on Airport During Maintenance of Runway Lighting (1-24-68)
AC 150/5200-8	Use of Chemical Controls to Repel Flocks of Birds at Airports (5-2-68)
AC 150/5200-9	Bird Reactions and Scaring Devices (6-26-68)
AC 150/5210-1	Airport Emergency Planning (8-15-63)
AC 150/5210-2	Airport Emergency Medical Facilities and Services (9-3-64)
AC 150/5210-3	Airport Emergency Operations-Aircraft Emergency (7-17-64)
AC 150/5210-4	FAA Aircraft Fire and Rescue Training Film, "Blanket for Survival" (10-27-65)
AC 150/5210-5	Painting, Marking, and Lighting of Vehicles Used on an Airport (8-31-66)
AC 150/5210-6	Aircraft Fire and Rescue Facilities and Extinguishing Agents (9-7-66)
AC 150/5210-7	Aircraft Fire and Rescue Communications (10-28-66)
AC 150/5210-8	Aircraft Firefighting and Rescue Personnel and Personnel Clothing (1-13-67)
AC 150/5210-9	Airport Fire Department Operating Procedures During Periods of Low Visibility (10-27-67)

AC 150/5210-10	Airport Fire and Rescue Equipment Building Guide (12-7-67)
AC 150/5220-1 thru 6	Guide Specifications for Airport Fire and Rescue Trucks and Water Supply Systems
AC 150/5230-1	Suggestions for Airport Safety Self-Inspection (3-30-64)
AC 150/5230-2	Guide Specification for Fire Extinguishing System (Foam) for Heliports (4-14-65)
AC 150/5240-1A	Airport Disaster Control Guide (10-31-67)
AC 150/5240-6A	Radiation Safety for Civil Airports (12-27-65)
AC 150/5300-2	Airport Design Requirements for Terminal Navigational Aids (3-30-64)
AC 150/5300-3	Adaptation of TSO-N18 Criterion to Clearways and Stopways (10-18-64)
AC 150/5300-4	Utility Airports-Design Criteria and Dimensional Standards (5-19-67)
AC 150/5310-1	Preparation of Airport Layout Plans (9-9-65)
AC 150/5310-3	FAA Order 5310.2, Relocating Thresholds Due to Obstructions at Existing Runways (5-27-68)
AC 150/5320-5A	Airport Drainage (1-28-66)
AC 150/5320-6A	Airport Paving (5-9-27)
AC 150/5325-2A	Airport Surface Areas Gradient Standards (5-12-66)
AC 150/5325-3	Background Information on the Aircraft Performance Curves for Large Airplanes (1-26-65)
AC 150/5325-4	Runway Length Requirements for Airport Design (4-5-65)
AC 150/5325-5A	Aircraft Data (1-12-68)
AC 150/5325-6	Effects of Jet Blast (4-15-65)
AC 150/5325-7	Is Your Airport Ready for the Boeing 747 (1-23-68)
AC 150/5330-2A	Runway/Taxiway Widths and Clearances for Airline Airports (7-26-68)
AC 150/5330-3	Wind Effect on Runway Orientation (5-5-66)
AC 150/5335-1	Airport Taxiways (1-28-65)
AC 150/5335-2	Airport Aprons (1-27-65)
AC 150/5340-1A	Marking of Serviceable Runways and Taxiways (6-30-66)
AC 150/5340-4A	Installation Details for Runway Centerline and Touchdown Zone Lighting Systems (8-4-66)
AC 150/5340-5	Segmented Circle Airport Market System (8-1-63)
AC 150/5340-7A	Marking and Lighting of Deceptive, Closed, and Hazardous Areas on Airports (1-10-68)
AC 150/5340-8	Airport 51-foot Tubular Beacon Tower (6-11-64)

AC 150/5340-13A	High Intensity Runway Lighting System (4-14-67)
AC 150/5340-14A	Economy Approach Lighting Aids (3-7-67)
AC 150/5340-15A	Taxiway Edge Lighting System (11-1-67)
AC 150/5340-16A	Medium Intensity Runway Lighting System (12-19-67)
AC 150/5340-17	Standby Power for Non-FAA Airport Lighting Systems (1-25-68)
AC 150/5345-1A	Approved Airport Lighting Equipment (8-9-66)
AC 150/5345-2 thru 37B	Airport Lighting and Electrical System Specifications
AC 150/5345-38	Changes to Airport Lighting Equipment (8-9-66)
AC 150/5360-1	Airport Service Equipment Buildings (4-6-64)
AC 150/5360-2	Airport Cargo Facilities (4-6-64)
AC 150/5360-3	Federal Inspection Service Facilities at International Airports (4-1-66)
AC 150/5370-1A	Standard Specifications for Construction of Airports (5-28-68)
AC 150/5370-2	Safety on Airports During Construction Activity (4-22-64)
AC 150/5380-1	Airport Maintenance (4-14-63)
AC 150/5380-2A	Snow Removal Techniques Where In-Pavement Lighting Systems are Installed (12-24-64)
AC 150/5380-3	Cleaning of Runway Contamination (6-28-68)
AC 150/5390-1	Heliport Design Guide (11-3-64)

b. Advisory Circulars Pending Issuance/Completion.

AC 150/5200-10	Airport Emergency Operations Planning
AC 150/5300-5	Airport Reference Point
AC 150/5330-2A	Runway/Taxiway Widths and Clearances for Airline Airports
AC 150/5340-18	Taxiway Guidance Sign System
AC 150/5380-4	Ramp Operations during Periods of Snow and Ice Accumulation
AC 150/5300-	Utility Airports
AC 150/5300-	Business Jet and General Transport Airport Design Standards
AC 150/5325-	Compass Calibration Pad
AC 150/5230-	Runway Surface Condition Measuring, Recording, and Reporting
AC 150/5340-	Taxiway Centerline Lighting System
AC 150/5340-1B	Marking of Serviceable Runways and Taxiways (revision)
AC 150/5355-	Fallout Shelters in Terminal Buildings
AC 150/5210-	Response to Aircraft Emergencies
AC 150/5220-	Aircraft Arresting Systems for Joint Civil/Military Airports
AC 150/5230-	Aircraft Fueling and Grounding

CHAPTER 3. AIRPORT SYSTEM IMPLEMENTATION

1. System Description

Neither public nor private airport planning, investment, and development have kept pace with the needs of current operations. This has already created a backlog of urgent airport development requirements which, together with advancing aircraft technology and accelerated public acceptance of air transportation, makes it imperative that Federal leadership stimulate greater participation in the system's development.

Because of the limited scope of the current National Airport Plan, the Nation lacks factual assessment of the financing needed to produce an adequate airport system for the next decade. Particularly lacking is the knowledge of the full costs of airport development necessary to meet the economic objectives of the several states and their political subdivisions.

An airport's development is a strongly motivated and proper responsibility of the community or region it serves. During the last 20 years, the Federal Government has aided over 2,200 communities in meeting that responsibility through a program of direct financial grants. By such action the Government has, except during recent years, induced the development of the ground segment of the civil aviation system at a pace commensurate with the growth of other elements of the system. However, recent system growth and the rapid growth anticipated during the next few years signals a future demand for investments in airports which clearly may tax the present system of fulfilling capital requirements. To go beyond the levels of funding which have been historically available is likely to require modification of financial mechanisms if growth is to be sustained.

Nevertheless, there can be no lessening of the national interest in ensuring adequate development of the national system of civil airports. A community's development motivation is heavily slanted towards its airport's terminal area because it is a visual extension of the community's image, as well as being a readily self-supporting entity. In contrast, the community stimulus is less, and the national interest is greatest in ensuring adequate development of the airport's airfield system supportive to movement of people and goods. There, the national interest is grounded in operational safety, and in the control and efficient utilization of the Nation's airspace. It is further meshed with the air transportation needs of interstate commerce, the Nation's economic growth, and the

requirements of our postal service and national defense. For these reasons, there is positive and continuing need to Federally influence adequate airfield area development at all airports comprising the national system.

The problem presented is that of providing the initial source of funding required in the near term, in order that needed development may proceed and be responsive in a timely manner. Therefore, the future Federal role takes shape to provide guidance on mechanisms by which the needed capital funding is first provided, and then lead to orderly and systematic development throughout the national airport system.

On behalf of the Secretary of Transportation, the FAA administers or participates in assistance programs for airport system development as briefly described below:

a. Federal Financial Assistance Programs.

(1) Federal-aid Airport Program (FAAP)-Planning/Construction Grants. The Federal Airport Act as amended (49 U.S.C. 1101-1120) authorizes a grant-in-aid program to assist public agencies such as states, counties, and municipalities in developing public airports. Under the provisions of the Program, Federal assistance may be made available on a matching fund basis (usually 50 percent) for the cost of advanced planning, for the acquisition of the necessary land for the airport and for the facilities needed for its safe operation, such as runways, taxiways, and aprons. Unless appropriations are authorized, grant authority under this program terminates in Fiscal Year 1970.

(2) DHUD 701 - Planning Grants. Authority: Title VII of the Housing Act of 1954, as amended. (40 U.S.C. 460-462) The program contributes to the development of a national system of airports by providing Federal aid for "comprehensive planning" that may include land use, community facilities, and transportation plans. The FAA role in the program is one of encouragement of this type of planning on the part of FAAP sponsors and of coordination with DHUD to assure consideration of air transportation as an integral part of 701 plans.

(3) EDA Planning and Construction Grants. Authority: The Public Works and Economic Development Act of 1965, as amended (43 U.S.C. 3121-3226). The program contributes to development of a national system of airports by providing Federal aid for airport

development by direct grants or grants supplementary to FAAP grants. Direct grants may be made for certain development such as hangars or terminal buildings not eligible under FAAP as well as for FAAP eligible projects that cannot be financed due to funding limitations during a specific fiscal year. The FAA role in the direct grant program is one of coordination with EDA and advisory service to provide the disciplines to assist EDA in their own evaluation of the sponsor's application and in carrying out construction. Supplementary grants are for the purpose of supplying a portion of the sponsor's share of costs in a FAAP development or advance planning project. After the EDA transfers funds to the Department for this purpose, the FAA administers the project. The only added role is connected with fund transfers and providing information to the EDA.

(4) Appalachian Regional Development Act of 1965 as amended 1967 (40 U.S.C. app. 102). Sec. 214. Authorizes supplemental grant of Appalachia funds to increase Federal contribution to projects above the maximum contribution allowed under FAAP. This is to enable public agencies to take maximum advantage of grant-in-aid programs for which they are eligible but for which, because of their economic situation, they are unable to supply the required matching funds.

ARC transfers the needed funds to the DOT and they are administered together with FAAP contribution to the project by FAA.

b. Federal Property Assistance Program.

(1) Federal Airport Act of 1946, as amended. (49 U.S.C. 1115) authorizes the Secretary to recommend the conveyance of any Federal land for airport purposes by the owning or controlling Federal agency under Section 16 of the Act. Once conveyed, FAA assures that the land is developed and used for airport purposes.

(2) Surplus Property Act of 1944 as amended. (50 U.S.C. app. 1622(g)) Federal surplus real and related personal property recommended by FAA for airport aeronautical and revenue producing purposes. Once conveyed by GSA, FAA assures its use by grantees for airport purposes only.

(3) Federal Property and Administrative Services Act of 1949, as amended. (40 U.S.C. 471-42[illegible]) FAA recommends to GSA the disposal of donable personal property to public agencies for direct use in the development, operation, improvement, or maintenance of public airports. Once conveyed, FAA assures its continued use by grantee.

(4) **Federal Military Facilities.** Under Section 1107 - Federal Aviation Act (49 U.S.C. 1500) certain military facilities may be made available for public use when determined by DOD not to be inconsistent with a military program or which benefits the military program. Includes development at joint use airports, permits, licenses, and easements. Use granted generally without cost by negotiation. FAA recommendation may be requested by DOD.

(5) Public Airport Leasing Act of 1928, as amended. (49 U.S.C. 211-214) Act authorizes the Secretary of the Interior to lease public lands to public agencies and private parties as public aviation facilities. Land area covering up to 2,560 contiguous acres may be leased. FAA may be requested to rate type of airport facility required to be developed.

(6) Department of Interior Airports. Act of March 18, 1950 (16 U.S.C. 7A-7E) authorizes the Secretary of Interior to acquire, construct, operate, and maintain public airports in or in proximity to national parks, monuments, and recreation areas. Location must be listed in NA . Operation and maintenance must meet the FAA standards, rules, or regulations of the FAA.

Aeronautical research and development efforts have historically been confined both by government and industry to projection of market demands and the development of three of the four elements of the air transportation system; i.e., the vehicle (Aircraft), the way (National Airspace System), and control (Air Traffic System). The fourth element — the terminal (Airport) — has been merely reactive, adjusted, and readjusted to accomodate improvements and changes in other elements of the total system.

a. At the present time, systems to arrest civil aircraft upon landing are not technically proven. Additional study and research is required. Until such time as the safety and technological problems have been resolved, it does not appear that any system will be incorporated into civil airport development.

b. Other items of airport safety which have been under investigation but which require further attention are the use of runway paving materials and surface grooving to improve aircraft stopping capabilities, obstruction protection, development of snow removal techniques, measurement and reporting of adverse runway conditions, fog dissipation, and alleviation of bird problems near airports.

c. Large capacity jets, for example, although not expected to significantly affect runway acceptance rates, will heavily tax the existing cargo and passenger handling capabilities. Although the SST is not expected to materially affect runway capacity, planning criteria should consider the high cost of their delay which will be much greater than for conventional aircraft. V/STOL aircraft, to effectively add to and not derogate capacity at congested terminals, must be able to operate independently from conventional aircraft and under rules that recognize their performance flexibility.

The need for a fully integrated, long range airport research and development program has never been more critical than at the present time. Effective R&D for the 1980 - 90 time period must be initiated within the next few years in order to have an effective and timely impact on system development.

Current FAA guidelines and criteria used in national airport system development and associated technical advisory services available to the public are listed in the Bibliography section.

2. System Requirement.

There is a requirement for a nationwide system of public airports adequate to meet the present and future needs of civil aeronautics. The FAA provides assistance (including the conveyance of real and personal property) to airport sponsors and planning bodies to actively pursue the timely development of the national system of civil airports. Agency action in the form of assistance, however, will be kept to the minimum necessary to assure the availability of a system of public use airports to support civil aviation as identified within the National Airport Plan.

There is also a need for the agency to promote and undertake airport research and development to accompany and be an integral part of aeronautical research in order that total system costs and benefits can be analyzed and full consideration be given to trade-offs among principal elements of the air transportation system.

3. System Goals.

The FAA has established as its airport system development program objectives:

a. The identification and determination, on a continuous basis, of the financial assistance roles of (a) the Federal Government, (b) state

and local governments, and (3) the system users — airlines, general aviation, airport management, passengers, air freight shippers, etc.

b. The coordination and facilitation of all available Federal programs which can assist in the development of any airport component or the provision of necessary supporting services; such as for airport terminal area facility development, the establishment of rapid transit access, the assurance of compatibility of area development, etc.

c. Where factors other than financial deter system development, such as multi-jurisdictional disputes regarding airport locations, to assist in their early resolution.

d. The determination and undertaking of airport research and development in order to anticipate the system planning and standards development needs of the future.

4. Bibliography.

a. Published Documents.

(1) U. S. Congress, The Federal Aviation Act of 1958, Public Law 85-726, Washington, D.C., August 23, 1958 as amended (49 U.S.C. 1301-1541) Section 308(a).

(2) U. S. Congress, The Federal Airport Act of 1946, Public Law 79-377, Washington, D.C., May 13, 1946 as amended (49 U.S.C. 1101-1120) Sections 4(a&b), 5(a&b), 5(d)(3), 11 and 16(a).

(3) U. S. Congress, The Surplus Property Act of 1944 as amended (50 U.S.C. app. 1622).

(4) Federal Aviation Agency, FAA Federal-aid Airport Program Handbook, Agency Order 5100.1A, January 10, 1966 and changes 1 - 30.

(5) Federal Aviation Agency, Federal Aviation Regulations listed below by FAR Part, title, and date (as amended by Code of Federal Regulations January 1, 1968 edition).

FAR Part 151, Federal Aid to Airports (14 CFR Part 151)
FAR Part 153, Acquisition of U.S. Land for Public Airports (14 CFR Part 153)
FAR Part 155, Release of Airport Property from Surplus Property Disposal Restrictions (14 CFR Part 155)

FAR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airports (14 CFR Part 157)

(6) Department of Transportation, Federal Aviation Administration (prior to April 1967, Federal Aviation Agency) pertinent Advisory Circulars are listed below by number, title, and date.[1/]

AC 150/5100-3A	Federal-aid Airport Program-Procedures Guide for Sponsors (9-20-68)
AC 150/5100-4	Airport Advance Planning (1-12-68)
AC 150/5150-2	Federal Surplus Personal Property for Public Airport Purposes (6-27-68)
AC 150/5190-1	Minimum Standards for Commercial Aeronautical Activities on Public Airports (8-18-66)
AC 150/5190-2	Exclusive Rights at Airports (9-2-66)
AC 150/5190-3	Model Airport Zoning Ordinance (1-16-67)

1/ A brief description of each Advisory Circular (AC) is contained in the Advisory Circular check list published periodically in the Federal Register (33 FR 14754-1477-10/2/68).

BOOK 1
1/27/69

PART VIII - PROPOSED STUDY ON COST ALLOCATION FOR THE FEDERAL AIRWAYS SYSTEM

PART VIII. PROPOSED STUDY ON COST ALLOCATION FOR THE FEDERAL AIRWAYS SYSTEM

INTRODUCTION

The proposed study discussed in the following pages is not a substantive part of the National Aviation System investment program of the FAA. It is, however, addressed to the problem of an equitable and economically efficient allocation of the costs of the Federal airways system in the future. As such, it bears an important relationship to the amount of investment funds which will be available in the future for improving and expanding the National Aviation System. It is included here, therefore, as a subject germane to the policies of the FAA.

PART VIII. PROPOSED STUDY ON COST ALLOCATION FOR THE FEDERAL AIRWAYS SYSTEM

1. Background and Purpose.

Since 1926 the Federal Government has provided, maintained and operated, for use by all categories of aircraft operators, both civil and military, a national system of air traffic control, flight advisory services, and aids to air navigation, together with a network of communications essential to the functioning of the system. This complex of facilities and services -- customarily called the Federal airways system -- has been planned and managed by and paid for from appropriations of the Federal Aviation Administration and its predecessor agencies.

The annual expenditures for the Federal airways system are substantial, and for the fiscal year 1969 will exceed $700 million. Larger annual expenditures in the future will be needed to improve, expand and operate the system to meet the demands of a rapidly growing civil aviation.

The cost responsibility for the system and pricing of the services provided are subjects of increased interest and importance to the Federal Government, the aviation community, and the public. Because the existing fuel and air travel taxes do not provide revenues sufficient to cover the civil users share of the costs of the airways system, the Administration has proposed new and additional taxes to be effective with the new fiscal year, to recover from these users a greater share of the system's costs.

As the aviation system continues to grow, it is evident not only that the airways system costs will continue to increase but, also, that the system's use and services will change in terms of individual categories of aviation. It is important, therefore, that cost allocations among the various beneficiaries be reviewed for their long term equity and applicability.

To accomplish this purpose, the FAA proposes to organize, with the advice and counsel of the aviation community, a comprehensive study, to be conducted over a period of approximately 15 months, on the subject of airways system cost allocation. The study will examine the relevant issues, develop a theoretical and conceptual framework for analysis, and recommend a methodology to provide the most equitable, economically efficient, and otherwise appropriate in terms of national objectives and total national welfare, cost allocation by the Federal Government of the services and facilities comprising the Federal airways system.

2. General Discussion.

For the purpose of this study, the Federal airways system will be defined, as it has in prior studies, to include only facilities and services for which the FAA has budget responsibility. The system does not include, on the other hand, all the programs and activities for which the FAA requests appropriations of the Congress. Specifically excluded from the airways system are these FAA programs: (1) operation of Washington National and Dulles International airports; (2) grants-in-aid for airports; (3) the development of the civil supersonic aircraft; and (4) safety regulatory activities related to aircraft airworthiness and certification, and airmen qualifications and proficiency. Funds expended directly for and in support of these programs are not considered airways expenditures. It should be noted that the Federal airways system does not include the Nation's airport facilities that are owned and operated by local and state governments, regional authorities, and private enterprises.

In prior years, the FAA has described the airways system as consisting of the following facilities and services: (1) air traffic control towers; (2) tower approach control facilities; (3) airport surveillance radars and radar beacons; (4) precision approach radars; (5) airport surface detection equipment; (6) radar approach control facilities; (7) instrument landing systems; (8) airport approach lighting; (9) air route traffic control centers and long-range radars; (10) the VORTAC navigation system; (11) L/MF facilities; (12) flight service stations, including weather services; (13) intermediate landing fields; and (14) the research and development projects related to above facilities and services. All the expenditures directly for and in support of these facilities and services are considered to be airways expenditures.

3. The Study Approach.

All the conceptual and empirical aspects of developing a methodology for allocating airways system costs are within the scope of this study effort. In FAA studies to date, a methodology has been developed for allocating annual cost responsibility among system users based on: (1) user identification in terms of three segments of aviation -- air carrier, general aviation and military aviation; (2) system disaggregation into the fourteen facility and service groups listed in the prior section of this statement; (3) system cost estimation for these groups in terms of maintenance and operation, depreciation and amortization of the capital and research and development expenditure; and imputed interest on the undepreciated and unamortized investment; and (4) aircraft traffic statistics indicating annual use of the facilities and services by air carrier, general aviation and military aviation. This new study will review that methodology but will not be limited to critiquing it.

The study will be divided into two phases: one devoted to the theoretical and conceptual framework; and the other consisting of the analytical work of developing the methodology for allocating airways system costs. The second phase need not await the completion of the first phase, but it appears logical that the substance and scope of the second phase work will be guided by the findings of the first phase. The study effort will include the work of field surveys to acquire a detailed knowledge of the functioning of the airways system from the viewpoints of both the FAA and the aviation users.

4. Basic Tasks of the Study Effort.

a. Examine in the light of economic principles, other public policy guidance, and national objectives, the theoretical and conceptual aspects of defining relevant costs and allocating cost responsibility for the services and facilities comprising the Federal airways system.

b. Develop a rationale for defining the scope and substance of the relevant airways system costs, given the description of the system provided above.

c. Develop a methodology for allocating the costs of airways system facilities and services based on the guidance developed in the theoretical and conceptual phase of the study. This methodology must be feasible in terms of reasonable administrative workload and costs to the FAA annually, and realistic in terms of the existing institutional environment and Federal Government responsibilities in the subject area of civil aviation as set forth in existing legislation.

d. Survey the traffic statistics and other available data indicative of airways system use, and devise a statistical reporting program to obtain any additional data needed to effect the airways system cost allocation in the manner called for by the theoretical and conceptual phase of the study.

5. Illustrative Questions.

The work of the study team should provide answers to questions such as the following:

a. To what extent are there economic or non-economic benefits accruing to the general public from the Federal airways system which justify allocating some portion of the system's costs to the general public?

b. What are the advantages and disadvantages of marginal cost and average cost allocation for the Federal airways system?

c. By what means can the use of the airways system by international air traffic, as distinct from domestic traffic, best be measured?

6. Coordination with the Aviation Community.

The FAA proposes to establish a small advisory group composed of aviation representatives to provide advice and counsel to the study team. This industry group will meet with the study team prior to the beginning of the study, and thereafter at appropriate times.

The purpose of the meetings will be: (1) to insure that the viewpoints of the industry on all the issues relevant to the study are considered by the study team in preparing its findings, conclusions and recommendations; and (2) to provide a means for the study team to acquire special industry information and data useful in the study effort.

The study team will be expected to explain its analytical approach and recommendations at the request of the group where differences arise but will not be required to achieve consensus. Each of the meetings with the industry group will be conducted in the FAA Headquarters building in Washington, D.C., or at a location chosen by the group, and are not expected to last longer than one day.

The establishment of the industry group will in no way preclude the study team from seeking expert counsel, information and data from other sources during the conduct of the study.

7. Reporting Schedule.

The study team will prepare the following reports:

a. An interim report presenting all the findings, conclusions and recommendations applicable to the theoretical and conceptual aspects of the study within six months of the beginning the study; and

b. A final report presenting in detail, together with a summary, all the findings, conclusions, and recommendations of the total study effort within fifteen months of the beginning of the study.